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ABSTRACT

A sociological theory of authority was used to investigate some nonintellective, perhaps unintended, consequences of computer-assisted instruction (CAI) upon student's attitudes and orientations toward the organization of the school. An attitudinal questionnaire was used to survey attitudes toward the teacher and the computer in a junior high school which serves predominantly Mexican-American families of low socioeconomic status. The questionnaire was administered before and after the experimental period. Results of regression analyses indicated that if CAI gets normative support from school officials who authorize its exercise of power as a monitor of students' task-specific behavior, and if teachers do not have control over that technological resource, students are likely to form authority relationships for goal attainment with the computer that are comparable to those usually formed with their teachers. This reduction in the students' dependence on the teacher's task-specific resources undermines the students' relationship with the teacher, especially with first-year CAI students. The longer range (second and third year) effects of the CAI program more favorably reflect some of the program's anticipated functions. (Author/JY)

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STANFORD CENTER
FOR RESEARCH AND DEVELOPMENT
IN TEACHING

Technical Report No. 29

THE COMPUTER AS AN AUTHORITY FIGURE: SOME EFFECTS OF CAI ON STUDENT PERCEPTION OF TEACHER AUTHORITY

Rodney L. Brod

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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A slightly different version of this paper, bearing the same title, was submitted to the School of Education, Stanford University, 1972, as a dissertation.

The Computer as an Authority Figure

ERRATA AND ADDENDA

Page xi, line 22: For "Thirty-four" read "Forty-two"

Page 8-9 (propositions 1 through 6) and throughout: For "authority system" read "authority relation"

Page 16, line 12: For "34" read "42"

Page 35, n. 10: After "teachers and peers." read "This reduction was significant for the peer group ($p < .01$), but not for the teachers."

Page 55: After the first sentence read "Although there were no Mexican-American math teachers during the pilot study, three of the five new teachers in 1969-70 were Mexican-American."

Page 82: All coefficients are significant beyond the .05 level.

Page 84: All coefficients are significant beyond the .05 level.

Page 86: All coefficients are significant beyond the .05 level.

Page 90: All coefficients are significant beyond the .05 level.

Page 92: Except for the Task-specific Power coefficient in equation VIII ($p < .25$), all coefficients are significant beyond the .05 level.

Page 94: Except for the Computer Evaluation coefficient in equation III ($p < .10$), all coefficients are significant beyond the .05 level.

INTRODUCTORY STATEMENT

The Center's mission is to improve teaching in American schools. Too many teachers still employ a didactic style aimed at filling passive students with facts. The teacher's environment often prevents him from changing his style, and may indeed drive him out of the profession. And the children of the poor typically suffer from the worst teaching.

The Center uses the resources of the behavioral sciences in pursuing its objectives. Drawing primarily upon psychology and sociology, but also upon other behavioral science disciplines, the Center has formulated programs of research, development, demonstration, and dissemination in three areas. Program 1, Teaching Effectiveness, is now developing a Model Teacher Training System that can be used to train both beginning and experienced teachers in effective teaching skills. Program 2, The Environment for Teaching, is developing models of school organization and ways of evaluating teachers that will encourage teachers to become more professional and more committed. Program 3, Teaching Students from Low-Income Areas, is developing materials and procedures for motivating both students and teachers in low-income schools.

The focus of this report from the program on Teaching Students from Low-Income Areas is the effect that experience with CAI has on students' perceptions of the teacher's role in the classroom.

TABLE OF CONTENTS

	Page
LIST OF TABLES	vi
LIST OF FIGURES	ix
ABSTRACT	xi
THEORETICAL AND CONCEPTUAL CONTEXT	1
The Problem	1
The Pilot Study	2
THE DESIGN OF THE STUDY	12
The Sample	12
The Treatment	12
The Design	15
RESULTS: THE COMPUTER AS AN AUTHORITY FIGURE	19
Computer and Teacher as Components of the School Authority Structure	19
Computer and Teacher: Some Sociological Elaborations	36
RESULTS: SOME EFFECTS OF CAI ON STUDENT PERCEPTION OF TEACHER AUTHORITY	53
Theoretical Additions and Modifications	53
Methodological Modifications	59
Effects of CAI Experience on Items and Indices Concerning Teacher Authority and Textbook Evaluation	71
Effects of Exogenous Indices of CAI Experience on Endogenous Variables of the Recursive Model	81
Measurement of Change: Evaluating the Causal Assumptions Underlying the Recursive Model	86
CONCLUSIONS AND IMPLICATIONS	96
BIBLIOGRAPHY	101
APPENDIX 1	102
APPENDIX 2	125

LIST OF TABLES

Table		Page
1	Characteristics of the Research Group	13
2	Characteristics of CAI and Non-CAI Groups	14
3	Posttest Correlations Among Task-Specific and Nontask-Specific Authority Rights for Teacher	21
4	Posttest Correlations Among Task-Specific and Nontask-specific Authority Rights for Computer	22
5	Posttest Comparisons Between Teacher and Computer on Authority Rights (Distributions and Means for CAI Group)	24
6	Posttest Comparisons Between Teacher and Computer on Task Allocation Items (Distributions and Means for CAI Group)	26
7	Sources of Control of Computer Task Allocations for Posttest (CAI Groups)	29
8	Posttest Comparisons Between Teacher and Computer Criteria of Task Evaluation (Distributions and Means for CAI Group)	30
9	Posttest Comparisons Between Teacher and Computer Evaluation of Task Performance (CAI Group)	33
10	Sanctions Following Poor Performance on Teacher-Assigned and Computer-Assigned Tasks: Percentages of "Yes" Responses for Posttest (CAI Group)	34
11	Propriety, Teacher Authorization and Endorsement of CAI[a] (Posttest Distributions and Means for CAI Group)	35
12	Posttest Intercorrelations Among Power Items[a] for Teacher (Non-CAI Group)	37
13	Posttest Intercorrelations Among Power Items[a] for Teacher (CAI Group)	38
14	Posttest Intercorrelations Among Power Items[a] for Computer (CAI Group)	39
15	Posttest Intercorrelations Among Computer-Items[a] Indicating Instability (CAI Group)	41
16	Posttest Intercorrelations Among Teacher-Items[a] Indicating Instability (CAI Group)	41

Table		Page
17	Posttest Intercorrelations Among Teacher-Items[a] Indicating Instability (Non-CAI Group)	42
18	Posttest Relationships Among Measures of Power, Instability, Incompatibility and Preference for Teacher (Non-CAI Group)	43
19	Posttest Relationships Among Measures of Power, Instability, Incompatibility and Preference for Teacher (CAI Group)	44
20	Posttest Relationships Among Measures of Power, Instability, Incompatibility and Preference for Computer (CAI Group)	46
21	Posttest Comparisons Between Teacher and Computer on Power (Resource Capacity) Items (CAI Group)	48
22	Posttest Comparisons Between Teacher and Computer on Measures of Incompatibility, Instability and Preference (CAI Group)	49
23	Posttest Intercorrelations Among Teacher Authority Indices (Non-CAI Group)	50
24	Posttest Intercorrelations Among Computer Authority Indices (CAI Group)	51
25	Posttest Correlation Between Goal Attainment Items (Total Group)	53
26	Posttest Correlations Among Teacher Evaluation Items (CAI and Non-CAI Groups)	54
27	Comparisons Between Pilot Study and Pretest Teacher Power Items (Means for 1968-69 and 1969-70 Students)	55
28	Comparisons Between Pilot Study and Pretest Teacher on Measures of Incompatibility, Instability, Preference, and Evaluation Items (Means for 1968-69 and 1969-70 Students)	56
29	Comparisons Between Pilot Study and Pretest Teacher Goal Attainment Items (Total Group)	58
30	Posttest Intercorrelations Among Teacher Indices (Total Group)	60
31	Predictions and Degrees of Fit of Model II and Model III for Posttest Teacher Authority Variables (Total Student Group)	64

Table		Page
32	Stepwise Multiple Regressions of a Recurisve System of Linear Equations Concerning Six Teacher Authority Indices (Total Posttest Group)	65
33	Posttest Intercorrelations Among Exogenous and Endogenous Indices Concerning the Teacher Authority System (Total Group)	69
34	Posttest Intercorrelations Among CAI Indices and Other Indices Concerning the Teacher Authority System (Total Group)	70
35	Analysis of Covariance: Comparisons Between CAI and Non-CAI Posttest Means, Adjusted for Pretest Scores on Goal Attainment Items and Index	71
36	Analysis of Covariance: Comparisons Between CAI and Non-CAI Posttest Means, Adjusted for Pretest Scores on Textbook Evaluation Items and Index	72
37	Analysis of Covariance: Comparison Between CAI and Non-CAI Posttest Means, Adjusted for Pretest Scores on Teacher Evaluation Items and Index	73
38	Analysis of Covariance: Comparisons Between CAI and Non-CAI Posttest Means, Adjusted for Pretest Scores on Incompatibility and Preference Indices	74
39	Analysis of Covariance: Comparisons Between CAI and Non-CAI Posttest Means, Adjusted for Pretest Scores on Monitoring Frequency Items and Index	75
40	Analysis of Covariance: Comparisons Between CAI and Non-CAI Posttest Means, Adjusted for Pretest Scores on Instability Items and Index	76
41	Analysis of Covariance: Comparisons Between CAI and Non-CAI Posttest Means, Adjusted for Pretest Scores on Criteria Inconsistency Items and Index	77
42	Analysis of Covariance: Comparisons Between CAI and Non-CAI Posttest Means, Adjusted for Pretest Scores on Power Items and Indices	79
43	Stepwise Multiple Regressions of the Recursive System of Linear Equations Indicating Effects of Exogenous Dummy Variables CAI1 and CAI2 on Endogenous Indices Concerning Teacher Authority (Total Group)	82

Table		Page
44	Stepwise Multiple Regression of the Recursive System of Linear Equations Indicating Effects of Exogenous Block- and Strand-type CAI Experience on Endogenous Indices Concerning Teacher Authority (Total Group)	84
45	Stepwise Multiple Regressions of the Recursive System of Linear Equations Indicating Effects of Exogenous Block-type CAI Experience on Endogenous Indices Concerning Teacher Authority (Total Group)	84
46	Stepwise Multiple Regression of the Recursive System of Linear Equations Indicating Effects of Exogenous Strand-type CAI Experience on Endogenous Indices Concerning Teacher Authority (Total Group)	86
47	Part 1 of the Stepwise Multiple Regressions of a System of Linear Equations Comprising a Change Model Concerning Some Effects of CAI on Student Perception of Teacher Authority (Total Group)	90
48	Part II of the Stepwise Multiple Regressions of a System of Linear Equations Comprising a Change Model Concerning Some Effects of CAI on Student Perception of Teacher Authority (Total Group)	92
49	Stepwise Multiple Regressions (Reduced Form) of a System of Linear Equations Comprising a Change Model Concerning Some Effects of CAI on Student Perception of Teacher Authority (Total Group)	94

LIST OF FIGURES

Figure No.		Page No.
1	Model I	63
2	Model II	63
3	Model III	63

ABSTRACT

This study used a sociological theory of authority to investigate some nonintellective, perhaps unintended, consequences of computer-assisted instruction (CAI) upon students' attitudes and orientations toward the organization of the school. In particular, it began to explore the extent to which CAI involves the student in complex systems of interaction that have unanticipated affective and social overtones in addition to and impinging upon the program's intended instructional function.

The research had two related foci: (a) the computer as an authority figure and (b) some effects of CAI on student perception of teacher authority. The first problem involved determining the extent to which students interacting with CAI come to regard the computer as having certain functions and certain authority rights over them that traditionally were held only the teacher. The second problem dealt with some of the ways in which being subject to the computer's exercise of authority affects students' perceptions of their regular authority figure, the teacher.

A questionnaire that focused on attitudes toward the teacher and the computer was administered in a pretest-posttest design to 150 junior high school students, predominantly from Mexican-American families of low socioeconomic status. Sixteen of the students had previously been assigned by their teachers to a CAI drill-and-practice program of remedial instruction in mathematics for one to two school years. Thirty-four of the students began the CAI program for the first time after the administration of the pretest. The questionnaire was used five months later to obtain posttest data from these same students.

Stepwise multiple regression techniques were then used to analyze some effects of CAI on student perception of teacher authority; that is, theoretical relationships among endogenous (dependent) variables concerning teacher power and authority, and exogenous (independent) variables, including CAI experience and other educationally relevant background information, were incorporated in a mathematical model of change expressed as a system of linear equations.

The results of the regression analyses indicate that if CAI gets normative support from school officials who authorize its exercise of power as a monitor of students' task-specific behavior, and if teachers do not have control over that technological resource, students are likely to form authority relationships for goal attainment with the computer that are comparable to those usually formed with their regular authority figure, the teacher. A major effect of such involvement in CAI is that it reduces student dependence on the teacher's task-specific resources; that is, it brings about a reduction in student perception of the teacher's task-specific power, which is a critical basis for task-specific

authority. By undermining this aspect of the teacher's authority, CAI has certain unanticipated and undesirable consequences, particularly for first-year CAI students' relationships with the teacher. Compared to these initial (first-year) effects, however, the longer range effects of the CAI program (for second- and third-year CAI students) more favorably reflect some of the program's anticipated functions.

THE COMPUTER AS AN AUTHORITY FIGURE

I. THEORETICAL AND CONCEPTUAL CONTEXT

A. The Problem.

This is one of a series of studies investigating the nonintellective, perhaps unintentional, consequences of computer-assisted instruction (CAI) upon students' attitudes and orientations toward the organizational system of the school.[1] While monitoring students' attitudes and expectations about the system is less deliberately incorporated in educational objectives, such outcomes are of increasing importance as the total potential socializing power of the school increases in the society. These outcomes include the students' acquisition of attitudes and expectations about the school as an institution; evaluations of the interrelationships among organizational participants and components; reactions to school norms; acceptance of the school's goals and modes of goal-directed behavior; and formation of attitudes and feelings concerning one's self and one's role as a student, including the need to attend to material assigned by the teacher and to perform or complete assigned tasks. This implies that a major instructional component, whether human or nonhuman, when introduced into a school system, modifies the instructional context of the school and acquires the potential to affect, in both planned and unintended ways, students' patterns of interaction within that system and beyond.

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[1]The following studies have been distributed by the Center thus far. R. D. Hess et al., The computer as a socializing agent: Some socioaffective outcomes of CAI, Technical Report 13. R. Miller & R. D. Hess, The effect upon students' motivation of fit between student ability and the level of difficulty of CAI programs, R&D Memorandum 84. I. D. Smith & R. D. Hess, The effects of computer-assisted instruction on student self-concept, locus of control, and level of aspiration, R&D Memorandum 89.

B. The Pilot Study.

In a recent study,[2] the author applied a sociological theory of authority to investigate some unintended consequences of computer-assisted-instruction (CAI) on students' attitudes and orientations toward the organizational system of the school. Results suggest that where CAI has been authorized by school officials to exercise task-specific authority rights or functions traditionally held only by the teacher, the computer may come to be regarded as a component of the school's authority structure and thereby modify students' perception of teacher authority.

The Computer as Part of the School's Authority Structure.

Theoretically, the social context of the school is organizational in the sense that it is a system in which differential power or resource capacity is associated with the occupants of various positions. As in other organizations, legitimation of the power systems of the school rests on the idea of authority; that is, in attempting to accomplish objectives, the occupants of various organizational positions rely on normative consent rather than force. Thus, a student's interaction with CAI, like his interaction with a teacher, can be viewed as resting on (1) a set of power-dependence relationships in which CAI may utilize its resource capacity to attempt to control the student's behavior toward goal attainment and (2) a set of norms or rules regulating both the control attempts of CAI and the student's responses to them.

The view of role relationships within the school system as resting on a differential distribution of resource capacity among the participants (or occupants of organizational positions) follows from

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[2]The pilot study was performed as part of an investigation reported in Hess et al., 1970.

Emerson's (1962) postulate that (1) power is the characteristic of a relationship rather than a person and (2) in a power-dependence relationship the power of A is proportional to the extent to which A can mediate between B and B's goals and inversely proportional to the extent that alternative power-dependence relations are available to B for goal attainment. Following this conceptualization one may explore the possibility that the experience of interacting with CAI may generate a power-dependence relationship between the student and the computer which may function as an alternative to the teacher-student power-dependence relationship and thereby modify the student's perception of the traditional authority structure of the school.

Thus, concern for the examination of the socializing effects of CAI, both planned and unplanned, derives from the idea that in a school where CAI is authorized by school officials to exercise certain functions traditionally held only by the teacher, the computer may come to be regarded as an authority figure. Thus, it may give rise to feelings, attitudes and expectations which are comparable to those usually held toward the teacher and, thereby, modify students' perception of the authority structure of the school, particularly their view of teacher authority.

The Design of the Pilot Study.

The sample. The research group for the pilot study came from a junior high school in the San Francisco Bay area, where students were selected for CAI by the Vice Principal upon the recommendation of their math teachers. Although the Non-CAI students in each instance were generally performing at a somewhat better level in math than their CAI classmates, some were also in need of remedial instruction in math; thus, the entire group should be regarded as a selected population.

The treatment. The CAI program used in this school as a remedial course in basic arithmetic operations utilized a block design; that is, blocks or sets of lessons are given to the student on the basis of weekly tests administered via computer. After each exercise is performed, the solution is instantly evaluated by the computer and, if correct, a new exercise from the problem set is presented. If the solution is not correct, the words, "No, try again" are typed out by the teletype. If the solution is not given within a certain time limit, the words "Try again" are repeated. The students are to attempt as many problems as they can in each (approximately 10 minute) session. At the end of the lesson the percentage of correct responses completed within the allotted time is typed out by the teletype at the bottom of the page. A sample of the program can be found in Appendix 2.

The instrument. The basic instrument used in the pilot study of the outcomes of CAI was a questionnaire based on a number of theoretical and conceptual considerations as well as preliminary interviews and observation of students taking CAI. The questionnaire included parallel items using a variety of scaling techniques. These items were devised to investigate the students' evaluative perception of the teacher compared to the computer along properties involved in two major functions: information dissemination and monitoring of the performance of tasks involved in the process of acquisition of the information available.

The design. In the pilot study the questionnaire (see Appendix 1) was administered in June 1969 to 189 junior high school students (50 of whom had taken CAI for at least one and up to two years) using a post hoc design, with no control over the allocation of subjects to the treatment (CAI) and the control (Non-CAI) groups. The structure of this design was developed to permit comparisons of attitudes toward the

teacher and the computer of students who had obtained experience in the CAI program with classmates who had not been involved in the program. This design permitted analysis of data relevant to (1) determining the parameters of the images students hold toward the computer relative to the teacher, (2) testing a set of hypotheses concerning measures of organizational power, incompatibility, instability, and preference as applied to the teacher and the computer, and (3) suggesting possible effects of participation in the CAI program, particularly on students' views of their teacher.

The Computer as an Authority Figure.

The data obtained from the students were grouped and examined by the author following specific theoretical frameworks developed to study the functioning of formal organizations (Emerson, 1962; Dornbusch and Scott, in press) in order to explore the possibility that experience with CAI may generate a power-dependence exchange between the student and the computer which could function concurrently with the teacher-student relationship; this might modify the students' perception of the authority structure of the school, particularly their view of teacher authority.

Comparisons between computer and teacher as components of the school authority structure. According to organizational sociologists Dornbusch and Scott (in press), the process which most saliently involves power-dependence relationships among organizational participants as well as attempts to achieve control over member activities toward goal attainment is the process of monitoring task performance. It is in the components of this process (i.e., in allocating tasks, setting criteria for evaluation, sampling or supervising task execution, and appraising task performance) that is reflected the style in which

participants interact (i.e., exercise authority rights and/or respond to the exercise of such rights by other organizational participants). "An authority right that is regularly exercised by one participant over another is termed an authority link between the two. The sum of all authority links connecting two participants constitutes, by definition, an authority relationship between the two. The constellation of all authority relations of a participant, both with others over whom he exercises rights and with those who exercise rights over him with respect to a given task constitutes his authority system for that task." (Scott, et al. 1967)

In some organizational settings authority links concerning a given task are distributed among a number of participants; that is, authority rights may be exercised over a given individual by a variety of persons, each of whom may hold one or more of these rights. In mapping the authority systems of school students, only rights exercised over them were relevant, since students are, at least formally, the lowest status participants in the organization of the school.

Emphasis was thus given to pupil-teacher authority relations since, traditionally speaking, in the process of monitoring task performance, the teacher may be authorized to attempt control of student behavior in terms of all task relevant authority rights. It was expected that the computer would be perceived by the CAI students as exercising these same task relevant authority rights but would not be perceived by them as exercising authority rights over nontask behavior, as would be expected on the part of the teacher.

As expected, analysis of the data indicated that the teacher was perceived by both CAI and Non-CAI students as exercising both task-specific and nontask-specific authority rights. In addition, CAI

students perceived the computer as exercising only those task-specific authority rights traditionally held by the teacher. These students also appeared to see the computer as having greater task-related power (resource capacity) and authority (legitimate exercise of power) than the teacher. That is, while the computer is perceived as highly powerful in the task area, the computer, unlike the teacher, is not perceived as utilizing its power in nontask areas for punishing, getting impatient, and correcting behavior. This suggests that while this may limit the range of behavior over which the computer may exercise its power, that within this specialized task domain, the computer's exercise of power achieves greater legitimacy (i.e., authority) than the teacher's. That is, the computer's attempts to monitor student behavior, like the teacher's, are authorized (i.e., obtain normative support among those superordinate to the power wielder) but have, in addition, definite boundaries and, therefore, achieve greater student endorsement (normative support among those subordinate to the power wielder).

Implications of the comparisons between computer and teacher: some sociological elaborations. One of the implications of this type of analysis is that it begins to differentiate the relative areas of human and nonhuman authority in the classroom. This distinction between the things that are human and those that can be implemented by nonhuman teachers is of great importance for a theoretical analysis of the teaching roles and for teacher training programs for teachers working with educational technology. In addition, it will be noted that compared to their Non-CAI peers, CAI students may have a more complex web of authority relations involving them in task-related activities for which the computer provides a concurrent authority system (or alternative set of authority relations) for goal attainment. Involvement in such

situations conceivably gives rise to comparison and differentiation among authority right holders in terms of formal and informal characteristics and activities. Thus, perception of discrepancies between the two authority systems involving teacher and computer (e.g., discrepancies in terms of task-specific power or resource capacity) may generate differentiations between the two in terms of preference.

Scott and his colleagues (1967) theorize that, in organizational settings, the participants' authority systems may become unstable, i.e., subject to internal pressure for change, when they receive evaluations which are unsatisfactory to them. Assuming that dissatisfaction with evaluations received implies that a participant sets for himself a level of acceptable performance evaluations, Scott et al. use the term incompatible to indicate unacceptable evaluations. In this terminology, incompatible authority systems (i.e., authority relationships perceived to yield unacceptable evaluations) are unstable (i.e., subject to internal pressure for change).

Theoretical propositions. To investigate the applicability of these theoretical notions to the function of educational institutions, data from the pilot study by Hess et al., 1970 were used by the author to establish empirical support for the following propositions:

1. The lower an authority's task-related power (resource capacity), the greater the incompatibility experienced in that authority system.

2. An incompatible authority system is likely to be unstable.

3. An incompatible authority system is unlikely to be preferred.

4. An unstable authority system is unlikely to be preferred.

5. An authority system in which the authority's task-related power (resource capacity) is low, is unlikely to be preferred.

6. The lower an authority's task-related power (resource capacity), the greater the instability in that authority system.

To examine the applicability of the theoretical propositions, data from the Non-CAI group were used only for the teacher authority system, since these students did not have experience of actual interaction with the computer. Data from the CAI group were used to examine the propositions for the computer authority system. In order to look for systematic differences in perception of the teacher authority system as a result of experience in CAI, data from the CAI group on items inquiring about the teacher were also used to examine the propositions, comparing the CAI students' perceptions of the teacher authority system with those held by their Non-CAI peers.

Results and interpretations of the data analysis. Following the propositions stated above it was expected that for each authority system, i.e., the teacher's and the computer's, the greater the power or resource capacity attributed to the figure, the less the likelihood that the system would generate experiences of incompatibility and instability and the greater the likelihood of preference for that system. For example, with respect to the teacher authority system, the measures of power were expected to be associated negatively with the measures of incompatibility and instability and positively with the measure of preference. It was also expected that the measure of incompatibility would be associated positively with the measures of instability and negatively with the measure of preference and that the measure of instability would be negatively associated with the

measure of preference. The same pattern of relationships was expected among the measures applying to the computer authority system.

The findings indicated that while there is a strong tendency for the derived propositions to hold among the teacher items for Non-CAI students and among the computer items for CAI students, this tendency was considerably reduced with respect to teacher items for CAI students. This was particularly true for the relationships among the measures concerning CAI students' perception of the teacher's power.

It was also shown that CAI students, compared to their Non-CAI peers, were significantly less inclined to attribute to the teacher charismatic qualities and reported significantly less satisfaction with having math problems allocated and evaluated by the teacher.

These data suggested that CAI students may become less dependent than their Non-CAI peers on the teacher's resources for goal achievement. This finding was interpreted to be congruent with Emerson's (1962) postulate that in a power-dependence relationship A's power over B is inversely proportional to the extent to which alternative (concurrent) power-dependence relations are available to B for goal attainment. That is, given the goal of learning mathematics and the specific tasks involved in this goal (i.e., solving math problems), it is conceivable that for CAI students, task-specific authority relations with the computer may function concurrently to their relations with the teacher in terms of both level and legitimacy of power, a critical basis for task-specific authority.

Thus, experience with concurrent authority relations (i.e., with both teacher and computer), may enhance a more realistic appraisal of both authority systems and thereby facilitate CAI students' chances for goal attainment. Of course, these data may have indicated only

that CAI students, compared to their Non-CAI peers, had less favorable attitudes toward their teachers before they obtained experiences of CAI. To clarify questions related to this problem further analyses have been made in this study using data obtained from students before and after their involvement in CAI.

II. DESIGN OF THE STUDY

A. The Sample.

The research group for the study came from a junior high school in the San Francisco Bay Area (the same one used in the pilot study during the previous academic year), where students were selected for CAI by the Vice Principal upon the recommendation of their math teachers. The criteria used in this selection process were (1) achievement level in math as judged by the math teachers and (2) standard test scores. Although the Non-CAI students in each instance were generally performing at a somewhat better level in math than their CAI classmates, some were also in need of remedial instruction in math; thus, the entire group should be regarded as a selected population. Demographic data were obtained from school files for each student who had filled out a questionnaire. These data included each student's sex, age, grade, math achievement level, intelligence test scores, socio-economic background, and ethnicity. Tables 1 and 2 show the characteristics of the students on these demographic items.

B. The Treatment.

The first half of the five months of the treatment consisted of a CAI remedial program of basic arithmetic operations, utilizing blocks or sets of lessons (the same as described in the pilot study section concerning treatment). The last half of the treatment employed the same printed format via the teletype (a sample is found in Appendix 2) but incorporated a strand-type rather than a block-type presentation of

TABLE I

Characteristics of the Research Group

Sex		Male	Female			Totals
	N	86	64			150
	%	57	43			100
Age		Below 13.7	13.7-14.6	14.7 & Above		
	N	51	60	38		149*
	%	34	40	26		100
Grade		7th	8th	9th		
	N	47	52	51		150
	%	31	35	34		100
Level of Performance in Math		Low	Intermediate			
	N	43	102			145**
	%	30	70			100
SES		Unskilled	Semiskilled			
	N	102	47			149*
	%	68	32			100
Ethnicity		Mex.-Amer.	Oriental	Black	Anglo-Amer.	Other
	N	122	3	7	15	3	150
	%	81	2	5	10	2	100
IQ		Below 80	80-89	90-99	100 & above		
	N	37	42	37	11		127***
	%	29	33	29	9		100
CAI vs. Non-CAI		CAI	Non-CAI			
	N	58	92				150
	%	39	61				100

*School files contained information for only 149 (out of 150) students.
**Math level of 145 (out of 150) students was rated by math teachers.
***School files included I.Q. scores for only 127 (out of 150) students.

TABLE 2

Characteristics of CAI and Non-CAI Groups

		CAI Group				Non-CAI Group			
Sex		Male	Female		Totals	Male	Female		Totals
	N	30	28		58	56	36		92
	%	52	48		100	61	39		100
Grade		7th	8th	9th		7th	8th	9th	
	N	20	16	22	58	27	36	29	92
	%	34	28	38	100	29	39	32	100
Level of Math Performance		Low	Intermediate			Low	Intermediate		
	N	24	34		58	19	68		87*
	%	41	59		100	22	78		100
IQ		Below 90	90 & above			Below 90	90 & above		
	N	39	12		51**	40	36		76**
	%	76	24		100	53	47		100

*Math level of 87 (out of 92) Non-CAI students was rated by teachers.
**School files included I.Q. scores for 51 (out of 58) students and 76 (out of 92) Non-CAI students.

problems. That is, rather than being presented blocks of problems each week predetermined on the basis of a weekly exam, the selection and presentation of each new problem is based upon the performance of the one just preceeding it. Also, the range over which the program can select problems is less limited with strands than it is with the relatively more finite block system. Thus, the strand-type presentation of material provided for even greater flexibility and individualization of programming than did the block style.

This shift towards greater flexibility and individualization of programming has important theoretical as well as methodological implications. Theoretically, students finding even greater degrees of flexibility and individualization with the strands-type program, may see it as less "remedial" in scope, thereby reducing their dependency on teacher resources, particularly in task-specific areas. Methodologically, it becomes necessary to separate the effects of blocks from stands, thus, the number of block and strand lessons completed by each CAI student was compiled in order to measure some important differences in the effects of these two types of treatment. The effects of the strands-type presentation is of particular concern, however, since this innovation has been incorporated by all of the schools currently using CAI math programs via the Stanford University based system.

C. The Design.

Overview.

The results of the pilot study analysis indicated significant differences between CAI and Non-CAI students' views of the teacher along several authority-related dimensions. For example, CAI students, compared to their Non-CAI classmates, were significantly less inclined to attribute to the teacher charismatic qualities and reported significantly

less satisfaction with having math problems allocated and evaluated by the teacher. Of course, the post hoc design of the pilot study did not permit analysis which (1) could rule out the possibility that CAI students, compared to their Non-CAI peers, had less favorable attitudes toward their teachers before they obtained experience with CAI, and (2) would examine the degree and direction of change in attitudes toward the teacher and the computer resulting from a period of exposure to CAI.

To permit analysis of data which would provide answers to these questions raised by the pilot study, the investigation employed a pre-test-posttest design. The questionnaire (the same one used in the pilot study) was administered to several math class groups (150 students) in December 1969 and May 1970. Of the 58 CAI students, 34 started the CAI program for the first time in January 1970 and, thus, provided before and after treatment (CAI) data. Again there was no control over the allocation of subjects to the treatment (CAI) and control (Non-CAI) groups; however, in this case, there was the possibility of controlling for pretreatment differences between the two groups. While the study did not utilize all of the 155 items, the entire questionnaire is included in Appendix 1.

The study design revolves around two related foci: (a) the computer as an authority figure and (b) some effects of CAI on student perception of teacher authority. The first problem involves determining the extent to which students involved in CAI come to regard the computer as exercising certain authority rights or functions over them traditionally held only by the teacher, while the second and related problem deals with some of the ways in which involvement in CAI (i.e., being subject to the computer's exercise of authority) affects student's perception of their regular authority figure, the teacher.

Computer as Authority Figure.

The first part of the investigation consisted of a replication of the pilot study using posttest data obtained in May 1970 from CAI students (with at least five months and up to three school years of CAI experience). First the data were analyzed to test the expectation that, given the specific task of learning to do math problems, CAI students would come to regard the computer as exercising task-specific authority rights to a degree similar to that of their regular authority figure, the teacher, thus providing CAI students with concurrent (or an alternative set of) authority relations for goal attainment. Again using posttest data, a set of sociological propositions involving measures of organizational power, incompatibility, instability and preference was tested for CAI and Non-CAI students in regard to the computer; these major relationships were expected to hold for both computer and teacher.

Some Effects of CAI on Teacher Authority.

After some theoretical and methodological reformulations were made to incorporate several additional sociological variables regarding teacher authority into a mathematical model or system, the study turned to investigate some effects of CAI on student perception of teacher authority. In particular, after-treatment (i.e., posttest, May 1970) means of CAI students were compared with those of their Non-CAI peers, with before-treatment differences having been held constant statistically using analysis of multiple covariance and partial correlation techniques. A major expectation, for example, was that posttest (after treatment) task-specific teacher power would be lower for CAI than for Non-CAI students, holding constant their pretest (before treatment) attitudes.

In addition, explorations were made regarding some effects of CAI on a mathematical model or system of equations, using stepwise multiple regression techniques. The dependent variables of particular concern were those which comprise the endogenous system of the model (i.e., task-specific and nontask-specific power, goal attainment, criteria inconsistency, monitoring frequency, incompatibility, instability, preference, and general evaluation, as applied to the teacher, and textbook evaluation). The main independent variable, or treatment, is experience of CAI. Length and type of CAI experience were also considered in the analysis.

III. RESULTS: THE COMPUTER AS AN AUTHORITY FIGURE

In the theoretical and conceptual discussion of the pilot study section, it was argued that an important dimension of the computer's potential to influence lies in the fact that it is an effective instrument fo monitoring student behavior. As a component of the authority structure of the school organization, the computer's monitoring of students' goal-oriented behavior, like that of the teacher, is subject to a system of norms or beliefs held by organizational participants. Following sociological theories developed to study the functioning of formal organizations (Emerson, 1962; Scott et al., 1967; Dornbusch & Scott, in press), this section explores the idea that experience with CAI may generate a power-dependence exchange between the student and the computer which could function concurrently with the teacher-student relationship; this might modify the students' perception of the authority structure of the school, particularly their view of the teacher.

A. Computer and Teacher as Components of the School Authority Structure.

Organizational sociologists (Scott et al., 1957; Dornbusch & Scott, in press) have identified several dimensions and sources of normative regulation (legitimation) of the exercise of power (resource capacity) by participants in organizations. They pay particular attention to (a) the degree to which subordinates acknowledge the existence of a normative order (validity); (b) the degree to which the subordinates approve of thi order (propriety); (c) those superiors in the system whose rules or beliefs support the exercise of power (authorization); and (d) those subordinates subject to, and whose beliefs support, the exercise of

power (endorsement). Scott and his colleagues argue that in formal power-dependence relations within an organization, task performance is the focus of attempts to achieve control over member activities toward goal attainment. The four components of this process (allocating a task, setting criteria for evaluation, sampling, and appraising task performance) can be regarded as authority rights or functions that the power wielder may be seen as authorized (and endorsed) to assume.

With respect to CAI, this study makes the basic assumption that CAI's introduction and adoption in a school implies that there is a set of norms on the basis of which school officials extend authority to the computer (as well as to the teacher) to exercise certain authority rights in attempting to control students' behavior toward goal attainment. Focusing on the attitudes and beliefs of the subordinates, items were devised (a) to establish whether students perceive the computer as having certain functions or rights to exercise power over them (the validity with which they perceive the computer exercising such rights; and (b) to obtain their estimates of the normative support (legitimacy) of these functions or rights in terms of authorization (whether they perceive them as supported by higher school authorities), endorsement (whether they perceive them as supported by other students), and propriety (whether they themselves support these functions).

Authority rights.

In this section of the study the central question is whether students perceived the computer and the teacher as exercising authority rights or functions over them. Students see the computer as exercising its power over them in task-specific areas in a general pattern similar to that of the traditional authority figure, the teacher. Items designed to explore the students' views on this point are presented in Table 3.

TABLE 3

Posttest Correlations Among Task-Specific and Nontask-Specific Authority Rights for Teacher

(CAI Group)[a]

	1	2	3	4	5	6	7	8	9
Task-Specific Authority Rights									
Item: The math teacher...									
1. Chooses which math problems to give you.	1.00								
2. Checks your math problems.	.16	1.00							
3. Helps you learn to do math problems.	.25**	.57**	1.00						
4. Helps you get better math grades.	.08	.30**	.43***	1.00					
5. Shows you how well or how poorly you are doing in math.	.20*	.15	.27**	.08	1.00				
6. Shows interest in the math work you do.	.18	.20*	.50***	.39***	.17	1.00			
Nontask-Specific Authority Rights									
Item: The math teacher...									
7. Punishes you when you do something wrong.	.21*	-.04	.10	.05	.01	.18	1.00		
8. Gets impatient with you.	.28**	-.02	-.09	-.19	-.01	-.33**	.37***	1.00	
9. Corrects your behavior.	.11	.12	.25*	.34**	-.03	.09	.25*	.19	1.00

[a]The sign of r's reflect the direction of the scale. See questionnaire (Appendix I).

* = $p < .05$
** = $p < .01$
*** = $p < .001$

TABLE 4

Posttest Correlations Among Task-Specific and Nontask-Specific Authority Rights for Computer

(CAI Group)[a]

	1	2	3	4	5	6	7	8	9
Task-Specific Authority Rights									
Item: The computer...									
1. Chooses which math problems to give you.	1.00								
2. Checks your math problems.	-.05	1.00							
3. Helps you learn to do math problems.	.11	.07	1.00						
4. Helps you get better grades.	.34**	.30*	.30*	1.00					
5. Shows how well or how poorly you are doing in math.	.45**	-.05	.16	.29*	1.00				
6. Shows interest in the math work you do.	.38**	.03	.24	.31*	.33*	1.00			
Nontask-Specific Authority Rights									
Item: The computer...									
7. Punishes you when you do something wrong.	.03	.01	.33*	.13	.13	.21	1.00		
8. Gets impatient with you.	-.17	.17	.20	.25	.07	.06	.18	1.00	
9. Corrects your behavior.	-.37*	-.14	.08	.01	-.02	-.08	.30*	.64***	1.00

[a]The sign of r's reflects the direction of the scale. See questionnaire (Appendix I).

* = $p < .05$
** = $p < .01$
*** = $p < .001$

Justification for distinguishing theoretically between task-specific and nontask-specific rights or functions is indicated by item intercorrelations found in Tables 3 and 4. The proportion of significant positive coefficients for task-specific items is greater than chance for both teacher and computer. Task-specific and nontask-specific authority rights items are generally uncorrelated. If there is any tendency toward association at all, it is that task-specific items are somewhat more positively related to nontask-specific items for the teacher than for the computer. These data, however, add some support for the distinction made between task-specific and nontask-specific authority rights.

It was expected that students interacting with CAI would report that (a) the computer exercises task-specific authority rights over them to a degree similar to that of the teacher, and (b) the teacher's exercise of power more frequently includes nontask-specific authority rights, since the computer's exercise of power over students is not likely in nontask areas of concern. These expectations are supported by comparisons between teacher and computer on authority rights items (see Table 5). CAI students perceive both teacher and computer as exercising all six task-specific authority rights or functions. The computer is perceived as exercising task-specific authority rights as frequently as the teacher in every case but one.[3]

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[3]Since the pilot study, there has been a significant reduction in the expectation that "the computer helps you learn to do math problems." This finding may represent students acquiring a more realistic view of the computer as exercising the more limited, programmatic remedial function intended in CAI. In addition, there is a significant increase in the degree to which students indicate "the teacher shows interest in the math work you do." This finding may reflect generally more interested teachers as a result of actual changes in personnel which took place at the school just after the pilot study. Also in the pilot study, the computer, significantly more often than the teacher, was

TABLE 5

Posttest Comparisons Between Teacher and Computer on Authority Rights
(Distributions and Means for CAI Group)

Items		Percent Distributions 1	2	3	Means	t[a]	
a. Task-specific functions		Almost Never	Some-times	Usually			
1. The...(T,C) chooses which math problems to give you.	Teacher	2	21	77	2.75	.10	N.S.
	Computer	8	11	82	2.74		
2. The...(T,C) checks your math problems.	Teacher	4	14	82	2.79	-.50	N.S.
	Computer	5	7	89	2.84		
3. The...(T,C) helps you learn to do math problems.	Teacher	4	28	68	2.65	3.71	***
	Computer	32	34	34	2.02		
4. The...(T,C) helps you get better math grades.	Teacher	13	47	40	2.27	-1.07	N.S.
	Computer	8	42	50	2.42		
5. The...(T,C) shows you how well or how poorly you are doing in math problems.	Teacher	8	45	47	2.40	-.43	N.S.
	Computer	9	37	54	2.46		
6. The...(T,C) shows interest in the math work you do.	Teacher	4	35	61	2.57	.59	N.S.
	Computer	10	33	57	2.47		
b. Nontask-specific rights							
1. The...(T,C) punishes you when you do something wrong.	Teacher	38	48	13	1.75	3.43	**
	Computer	81	12	8	1.27		
2. The...(T,C) gets impatient with you.	Teacher	28	49	23	1.94	1.09	N.S.
	Computer	61	9	30	1.70		
3. The...(T,C) corrects your behavior.	Teacher	19	36	45	2.26	5.24	***
	Computer	78	7	15	1.37		

[a]Two-tailed t.
** = $p < .01$
*** = $p < .001$

As expected for nontask-specific authority rights or functions, the computer, unlike the teacher, is not perceived as punishing, getting impatient, and correcting behavior. While this may limit the range of behavior over which the computer exercises authority, in task-related areas the computer, much like the teacher, has validity but may gain greater general endorsement than the teacher. One implication of this type of analysis is that it begins to differentiate the relative areas of human and nonhuman authority in the classroom. This distinction between the things that are human and those that can be implemented by nonhuman teachers is of great importance for a theoretical analysis of teaching roles and for training programs for teachers working with educational technology.

Modes of Assigning Tasks.

Another major question investigated in this section dealt with the students' views about the ways math assignments are handled by the teacher as compared with the computer. The items included were intended to inquire about (a) the styles of assigning or allocating tasks[4]; (b) authority figure predictability; (c) the responsiveness of CAI and the teacher to students' attempts to change these assignments (efficacy);

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perceived as showing students "how well or how poorly" they were doing in math; however, Table 5 indicates no differences on this item. This finding probably reflects both of the changes outlined above, i.e., a more realistic view of the computer's functions and a general increase in interest on the part of teachers. Further analysis of these and other changes and their implications for the study will be presented later (see Chapter 4).

[4]The first and third items can be thought of as tapping task-specific power, since the ways in which an authority figure assigns tasks may form important bases for student dependence upon that authority figure to attain goals; the second item serves as a check comparing the level of difficulty of teacher versus computer allocated tasks.

TABLE 6

Posttest Comparisons Between Teacher and Computer
on Task Allocation Items
(Distributions and Means for CAI Group)

Items		Percent Distributions 1	2	3	4	Means	t[a]	
		Never	Some-times	Usually	Always			
Modes of Assigning Tasks								
1. How often does the... (T,C) give you enough time to answer a question?	Teacher	6	51	21	21	2.57	1.40	N.S.
	Computer	15	54	20	12	2.29		
2. How often does the ...(T,C) give you math problems which are too hard?	Teacher	8	76	8	8	2.16	.86	N.S.
	Computer	16	67	16	2	2.04		
3. When a...(T,C) gives you math problems to do, how often do you understand what you are suppose to do?	Teacher	2	71	22	4	2.29	-2.36*	
	Computer	0	44	49	7	2.62		
Authority Predictability								
1. How often do you know what a...(T,C) is going to do next.	Teacher	18	73	9	0	1.91	4.00***	
	Computer	68	30	3	0	1.35		
Student Efficacy								
1. If you wanted to change something in a...(T,C) lesson, do you think you could change it?	Teacher	37	51	2	10	1.85	.17	N.S.
	Computer	59	19	3	19	1.81		
Satisfaction		No, not at all	Yes, some	Yes, much	Yes, very much			
1. Are you happy with having the...(T,C) choose which math problems to give you?	Teacher	17	60	15	8	2.15	.71	N.S.
	Computer	26	51	15	8	2.05		

[a]Two-tailed t.
* = $p < .05$
*** = $p < .001$

(d) the students' satisfaction with the task allocation process (see Table 6); and (e) the students' views about the sources of control over the assignment of tasks in the specific CAI program (see Table 7).

In general, CAI students have a favorable view of the computer's way of assigning tasks. They reported that the computer's task allocations are more often intelligible than are assignments made by the teacher. There were no significant differences in student perception of teacher and computer concerning how often enough time is given to perform an allocated task and how often allocated tasks are too difficult (see Table 6). This finding is interesting in light of the fact that the computer program is intended as remedial but imposes a time limit on every task.

While CAI students indicated that they "sometimes" know what a teacher is going to do next, they reported the computer to be even less predictable; that is, a clear cut majority of the CAI group (68%) reported that they "never" know what the computer is going to do next (see Table 6). In addition, although the difference between means for teacher and computer on the efficacy item were nonsignificant, the trend for the majority in each case was similar. There were, however, a few CAI students who perceived that they could "always" change something in a computer's lesson.[5] These measures suggest that CAI students may experience a greater degree of dependence on the computer's than the teacher's task-specific resources and authority, particularly with respect to modes of allocation.

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[5]These students represent a significant increase over the number found in this category for the pilot study. This finding may reflect an actual change in format of the CAI program from a block- to a strand-type presentation of tasks in which the student is provided greater flexibility and individualization of tasks. Thus, the student may see greater opportunity to "change something" in the computer's lesson, and still be unable to predict exactly what that change will be.

The data about student sense of efficacy over computer allocations can be further clarified by the students' views on the sources of control of task allocations in the specific CAI program they experienced (see Table 7). Thirty-eight percent of the CAI students appeared to think that the computer may determine its own allocations and 52% of them reported that it is their own previous performance which determines the content of the next computer allocation. However, since CAI performance is evaluated via computer, affirmative responses to these two alternatives may reflect a feeling that it is in the students' own performance as evaluated by the machine that lies an important source of control over task allocations. The proportions of affirmative responses to the remaining three alternatives (71% for "somebody at Stanford," 57% for "the computer supervisor," and 53% for "the math teacher") suggest that the majority of these CAI students see the sources of control of computer task allocations as being located not only outside of the math class but also outside of the school. If, as Trow (1966) suggests, the status of the teacher in relation to technology is dependent on his ability to control that technology, then student awareness of the teacher's lack of influence over CAI represents a shift in student perception of the authority structure of the school.[6]

There were no differences found in the degree to which students were satisfied with task allocations from the teacher compared to the

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[6]This change in perception of the authority structure of the school is further supported by significant shifts from pretest to posttest in students' responses to both the "teacher" and "Stanford" control items; that is, while "yes" responses increased from pretest (44%) to posttest (71%) for the "Stanford" item, they dropped from 81% to only 53% for "teacher" control.

TABLE 7

Sources of Control of Computer Task Allocations for Posttest
(CAI Groups)

Item:	%"Yes"
Which one decides what math lessons you get from the computer:	
Response categories:	
The math teacher decides	53
Somebody at Stanford decides	71
The score I got the day before decides	52
The computer supervisor decides	57
The computer decides	38

computer. The distribution of responses to this item indicates that the mode is "yes, some" for both teacher and computer.[7]

Setting Criteria for Evaluation.

What criteria do the computer and teacher use in evaluating performance in math? Five criteria were presented and students were asked to rate their importance from the point of view of the teacher and the computer. The relevant items are quoted in Table 8. Included into the cluster of these items is the distinction between task- and nontask-specific criteria of evaluation. It was expected that students would perceive the teacher as more likely than the computer to make evaluations of their task performance, at least in part, on the basis of nontask-

[7]In the pilot study, the distributions of response to this item indicate that while the mode was "yes, some" for the computer, it was "no, not at all" for the teacher. Again this significant increase in satisfaction with teacher allocations from pilot study to posttest may reflect a more resourceful image of teachers resulting from math personnel changes made in the school just after the pilot study.

specific criteria such as coming in late, being absent or talking too much. Unlike the computer's, the teacher's ev. ·ations are not made for every task performance and are, therefore, more likely to be inferences based on either past performance indicators or nontask-specific criteria. Support for this notion is indicated in Table 8.

TABLE 8

Posttest Comparisons Between Teacher and Computer Criteria of Task Evaluation (Distributions and Means for CAI Group)

Item:		Percent Distribution 1	2	3	4	$\bar{x}$	t^a	
What does the math (T,C) care about on the math problems you do?								
Task-specific criteria		No,not at all	Yes, a little	Yes, some	Yes, much			
1. How fast I do math problems.	Teacher	7	41	30	22	2.67		
	Computer	20	24	20	37	2.74	-.32	N.S.
2. If I get them right.	Teacher	2	21	33	44	3.19		
	Computer	17	17	31	35	2.85	2.00*	
3. If I get them done.	Teacher	9	20	33	39	3.02		
	Computer	18	9	32	41	2.95	.32	N.S.
4. Having a neat paper.	Teacher	16	31	33	20	2.58		
	Computer	36	20	32	22	2.31	1.23	N.S.
Nontask-specific criteria								
1. Other things, such as coming in late, being absent, talking too much.	Teacher	10	15	27	49	3.15		
	Computer	54	19	11	16	1.89	4.85***	

[a]Two-tailed t.
* = $p < .05$
*** = $p < .001$

CAI students appeared to think that both teacher and computer base their evaluations of student performance on task-specific criteria of "speed," "correctness," "completeness," and "neatness" (see Table 8) However, while there were no significant differences between teacher and computer on the alternatives denoting concern for "speed," "completeness," and "neatness," in these students' view, "correctness" is significantly more important for evaluations made by the teacher than by the computer, and "nontask-specific criteria" weigh significantly more in the teacher's than in the computer's evaluations. Thus, while "nontask-specific criteria" were thought to be among the most important for the teacher (just as important as "correctness"), nontask-specific criteria were least important for evaluations made by the computer.

Evaluation of Task Performance.

CAI students saw significant differences between teacher and computer in the ways they carry out the function of appraising task performance (see Table 9). For example, they believed that the computer evaluates their task performance more often than does the teacher. Furthermore, although they were aware that the teacher's evaluations had a greater influence on grades than did the computer's evaluations, and thus saw the computer's evaluations as less important,[8] they indicated

[8]This finding is further supported by the fact that while the pilot study revealed no differences between teacher and computer evaluations in terms of degree of importance, from the pilot study to the posttest there was a significant decrease in the importance attached to evaluations made by the computer.

no differences in satisfaction with having their performance in math evaluated by the computer as compared to having it evaluated by the teacher.[9]

These findings, that teacher evaluations were seen as having greater influence on grades and were therefore more important, are not surprising in light of the fact that, in this school, evaluations of students' performance in CAI are not taken into consideration in the computation of their math grades. On the other hand, finding that students receive more frequent feedback on their math performance via computer and finding no differences between teacher and computer evaluations in terms of degree of satisfaction may reflect the fact that the computer provides immediate and factual information about the quality of the students' performance. In order words, computer evaluations appear to be satisfying not so much for their contribution to external rewards (grades) but for the information they provide about students' level of mastery over the tasks in question, which contributes to intrinsic satisfaction.

Consequences of Poor Task Performance.

CAI students also believed that poor performance on tasks assigned by the teacher is more likely to evoke negative sanctions than is poor performance on tasks assigned via computer (see Table 10). Comparison

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[9]In the pilot study, CAI students reported significantly greater satisfaction with having their performance evaluated by the computer than by the teacher; however, from the pilot study to the posttest, students' satisfaction with having their work evaluated by the teacher increased significantly while it decreased significantly with respect to the computer. These findings appear to reflect the points discussed earlier, i.e., a generally more favorable view of teachers resulting from personnel changes and a more realistic view of the computer's functions and limitations.

TABLE 9

Posttest Comparisons Between Teacher and Computer Evaluation of Task Performance (CAI Group)

Items:		Percentage Distribution 1	2	3	4	Mean	t[a]
When you have done a math problem does the ...(T,C) tell you if you are right or wrong.		Never	Sometimes	Usually	Always		
	Teacher	4	45	33	18	2.65	-3.47***
	Computer	9	13	24	54	3.24	
Do you think that the scores you get on math problems from the...(T,C) change your math grade.		No, not at all	Yes, a little	Yes, much	Yes, very much		
	Teacher	10	43	15	33	2.70	3.96***
	Computer	50	31	13	6	1.75	
How much do you care about the scores the...(T,C) gives you on math problems you do.		Not at all	A Little	Much	Very Much		
	Teacher	2	12	33	53	3.37	5.29***
	Computer	2	47	37	14	2.63	
Are you happy with the scores the... (T,C) gives you on math problems.		No, not at all	Yes, a little	Yes, much	Yes, very much		
	Teacher	20	41	24	15	2.35	1.76 N.S.
	Computer	23	51	23	3	2.05	

[a]Two-tailed t.
*** = $p < .001$

of the percentages of "Yes" responses for teacher and computer indicates that CAI students believe that "poor grades," "teacher frowns," and the obligation to "stay after school" are more likely to follow poor performance on teacher-assigned than on computer-assigned tasks. Appar-

ently, poor performance on computer-assigned tasks is less likely to be subject to informal teacher sanctions such as subtle nonverbal cues of disapproval, if for no other reason, because students work at the teletype on their own.

TABLE 10

Sanctions Following Poor Performance on Teacher-Assigned and Computer-Assigned Tasks: Percentages of "Yes" Responses for Posttest (CAI Group)

Item: What can happen to students who do a poor job on math problems given by the...(T,C)?	% "Yes" Teacher	Computer
They get poor grades	80	53
The teacher frowns at them	46	21
The teacher won't like them	22	16
They have to stay after school	41	19

These findings are congruent with previously reported data which suggested that the teacher, unlike the computer, exercises authority rights over nontask-specific areas of behavior, uses nontask-specific criteria for evaluation of task performance and has little control over the allocation of computer tasks.

Measures of Propriety, Authorization, and Endorsement.

While several of the questionnaire items measure the degree of normative support for CAI, the items listed in Table 11 were included as specific measures of propriety, teacher authorization, and student endorsement of the computer's monitoring of student performance in math. The data show that CAI students perceive their teachers and peers as being significantly less enthusiastic than themselves in supporting the

computer's exercise of power. Thus, CAI students are committed to having authority relations for goal attainment with the computer, even in the face of strong and growing opposition to such relationships from two important sources of normative regulation.[10]

TABLE 11

Propriety, Teacher Authorization and Endorsement of CAI[a]
(Posttest Distributions and Means for CAI Group)

Items	Percent Distributions 1	2	3	Means
	Less	Same	More	
1. If you could choose, would the computer score more, the same or less of your math problems?	11	54	36	2.25
2. If your math teacher could choose, would the computer score more, the same, or less of your math problems?	32	52	16	1.84
3. If your friends could choose, would the computer score more, the same, or less of their math problems?	43	39	18	1.75

[a]Two-tailed t's between Items 1 and 2 (2.45*), 2 and 3 (.45 N.S.), and 1 and 3 (2.94**).
* = $p < .05$
** = $p < .01$

[10]No differences among the means on these items were found for the CAI group in the pilot study, i.e., substantial normative support was accorded to CAI from all three sources of legitimation; however, from the pilot study to the posttest, CAI students continued to consider the computer's exercise of power as appropriate but reported a significant reduction of normative support on the part of both teachers and peers.

B. Computer and Teacher: Some Sociological Elaborations.

As we have seen, the teacher is perceived by CAI students as exercising both task-specific and nontask-specific authority rights. It has also been shown that CAI students perceive the computer as exercising task-specific rights or functions traditionally held only by the teacher. These students also appear to see both computer and teacher as having task-specific power (resource capacity) and authority (legitimate exercise of power). Thus, compared to their Non-CAI peers, CAI students appear to have a more complex web of authority relations involving them in task-related activities for which the computer provides a concurrent authority system (or set of authority relations) for goal attainment. As argued earlier, involvement in such situations conceivably gives rise to comparison and differentiation between teacher and computer in terms of preference.

In addition, Scott and his colleagues (1967) theorize that, in organizational settings, the participants' authority systems may become unstable (i.e., subject to internal pressure for change) when they receive evaluations which are unsatisfactory to them. Thus, incompatible authority systems (i.e., authority relationships perceived to yield unacceptable evaluations) are unstable (i.e., subject to internal pressure for change).

Operationalization.

Following Emerson's (1962) conception of power-dependence relations, power was defined in the following way: A has power over B to the extent that B perceives A to have the resource capacity to mediate between B and B's goals. Power was defined operationally in terms of the six items quoted in Tables 12 through 14; however, based upon Scott et. al., who suggest that assigning a task is assigning a specific goal, a dis-

tinction was made between task-specific and nontask-specific power. Thus, for students being assigned math problems, task-specific power was operationalized in terms of the first three items, whereas nontask-specific power was measured by the remaining three.

TABLE 12

Posttest Intercorrelations Among Power Items[a] for Teacher (Non-CAI Group)

Items	1	2	3	4	5	6
Task-specific power						
1. A teacher could help improve your math grades in one month.	1.00					
2. How often does a teacher give you enough time to answer a question?	.29**	1.00				
3. When a teacher gives you math problems to do, how often do you understand what you are suppose to do?	.13	.18*	1.00			
Nontask-specific power						
4. A teacher can answer almost all your questions.	.21*	.19*	.28**	1.00		
5. How much information does a teacher have?	.19*	.26**	.18*	.37***	1.00	
6. I believe a teacher will always be right.	.05	.07	.20*	.08	.14	1.00

[a]Where appropriate, the response scale has been reversed.

* = $p < .05$
** = $p < .01$
*** = $p < .001$

TABLE 13

Posttest Intercorrelations Among
Power Items[a] for Teacher
(CAI Group)

Items	1	2	3	4	5	6
Task-specific power						
1. A teacher could help improve your math grades in one month.	1.00					
2. How often does a teacher give you enough time to answer a question?	.29*	1.00				
3. When a teacher gives you math problems to do, how often do you understand what you are suppose to do.	.25*	.25*	1.00			
Nontask-specific power						
4. A teacher can answer almost all your questions.	.15	.11	.20	1.00		
5. How much information does a teacher have?	.37**	.41***	.11	.41***	1.00	
6. I believe a teacher will always be right.	.39**	.35**	.05	.35**	.41***	1.00

[a]Where appropriate, the response scale has been reversed.
* = $p < .05$
** = $p < .01$
*** = $p < .001$

The degree to which these items were interrelated for both teacher and computer justifies their being considered as measuring a common dimension of the students' perception of these two sources of authority. For all the students, 10 (67%) of the 15 correlations among the power items for teacher were significant (see Tables 12 and 13) and for CAI

students, 5 (33%) of the 15 items for the computer are significant (see Table 14). In all three instances, the proportions of significant relationships were greater than what would be expected by chance.

TABLE 14

Posttest Intercorrelations Among Power Items[a] for Computer (CAI Group)

Items	1	2	3	4	5	6
Task-specific power						
1. A computer could help improve your math grades in one month.	1.00					
2. How often does a computer give you enough time to answer a question?	.18	1.00				
3. When a computer gives you math problems do do, how often do you understand what you are suppose to do?	.14	.10	1.00			
Nontask-specific power						
4. A computer can answer almost all your questions.	-.07	.24*	.30*	1.00		
5. How much information does a computer have?	.04	.34**	.16	.22	1.00	
6. I believe a computer will always be right.	.05	.23	.28*	.09	.24*	1.00

[a]Where appropriate, the response scale has been reversed.
* = $p < .05$
** = $p < .01$

To provide indications of instability (i.e., internal pressure for change) in the teacher's and the computer's authority systems, three

items were used. These dealt with (a) degree of satisfaction with task allocations, (b) degree of disagreement with messages transmitted, and (c) liking for performing tasks with the teacher compared to the computer (see Tables 15 through 17). That these items can be thought of as indicators of a common dimension of the students' perception of the teacher and computer authority systems is suggested by the extent to which they are interrelated (see Tables 15 through 17).

The item dealing with preference for teacher, computer, textbook or television as sources of monitoring behavior oriented toward learning mathematics may also be regarded as a measure of instability. The relationships of this item to the measures of task-related power, instability and incompatibility pertaining to teacher and computer authority systems are shown in Tables 18 through 20.

A single item was used as an indicator of incompatibility. This item dealt with the degree of satisfaction with performance evaluations by the teacher as compared to the computer. The relationships of this item to the previously mentioned measures are shown in Tables 18 through 20.

Theoretical Propositions.

To investiage the applicability of this theory to the functioning of educational institutions the posttest data were used to examine the following propositions:

1. The lower an authority's power (resource capacity), the greater the incompatibility experienced in that authority system.
2. An incompatible authority system is likely to be unstable.
3. An incompatible authority system is unlikely to be preferred.
4. An unstable authority system is unlikely to be preferred.

TABLE 15

Posttest Intercorrelations Among
Computer-Items[a] Indicating Instability
(CAI Group)

Items	1	2	3
1. How often do you disagree with what a computer says?	1.00		
2. Are you happy with having the computer choose which math problems to give you?	.21	1.00	
3. Do you like doing math problems with the computer?	.18	.09	1.00

[a]Where appropriate, the response scale has been reversed.

TABLE 16

Posttest Intercorrelations Among
Teacher-Items[a] Indicating Instability
(CAI Group)

Items	1	2	3
1. How often do you disagree with what a teacher says?	1.00		
2. Are you happy with having the teacher choose which math problems to give you?	.13	1.00	
3. Do you like doing math problems with the teacher?	.16	.58***	1.00

[a]Where appropriate, the response scale has been reversed.
*** = $p < .001$

TABLE 17

Posttest Intercorrelations Among
Teacher-Items[a] Indicating Instability
(Non-CAI Group)

Items	1	2	3
1. How often do you disagree with what a teacher says?	1.00		
2. Are you happy with having the teacher choose which math problems to give you?	.29***	1.00	
3. Do you like doing math problems with the teacher?	.33***	.56***	1.00

[a]Where appropriate, the response scale has been reversed.
*** = $p < .001$

5. An authority system in which the authority's power (resource capacity) is low, is unlikely to be preferred.

6. The lower an authority's power (resource capacity), the greater the instability in that authority system.

To examine the applicability of these propositions based on the theory of Scott and his colleagues, data from the Non-CAI group were used only for the teacher authority system, since these students did not have experience of actual interaction with the computer. Comparison between the authority systems of teacher and computer was based on data from the CAI group only.

Following the propositions stated above it should be expected that for each authority system, i.e., the teacher's or the computer's, the greater the power or resource capacity attributed to the figure, the less the likelihood that the system would generate experiences of incompatibility and instability and the greater the likelihood of preference for that system. For example, with respect to the teacher

TABLE 18

Posttest Relationships Among Measures of Power, Instability, Incompatibility and Preference for Teacher (Non-CAI Group)

Items	Instability 7	8	9	Incompatibility 10	Preference 11
Task-specific power					
1. A teacher could help you improve your grades in one month.[a]	+.03	-.39***	-.34***	-.37***	.25**
2. How often does a teacher give you enough time to answer a question?	-.26**	-.38***	-.44***	-.31***	.15
3. When the teacher gives you math problems to do, how often do you understand what you are supposed to do?	-.25**	-.36***	-.32***	-.29**	.27**
Nontask-specific power					
4. A teacher can answer almost all your questions.[a]	-.15*	-.12	-.30***	-.24**	.08
5. How much information does a teacher have?	-.13	-.21*	-.41***	-.17	.29**
6. I believe a teacher will always be right.[a]	-.16*	-.17*	-.23**	-.28**	.02
Instability					
7. How often do you disagree with what a teacher says?				.27**	-.17*
8. Are you happy with having the teacher choose which math problems to give you?[a]				.49***	-.32***
9. Do you like doing math problems with the teacher?[a]				.53***	-.29***
Incompatibility					
10. Are you happy with the scores the teacher gives you on math problems?[a]					-.18*
Preference					
11. I would prefer to learn math from a teacher.[a]					

[a]Where appropriate, the response scale has been reversed.

* = $p < .05$
** = $p < .01$
*** = $p < .001$

TABLE 19

Posttest Relationships Among Measures of Power, Instability, Incompatibility and Preference for Teacher (CAI Group)

Items	Instability 7	8	9	Incompatibility 10	Preference 11
Task-specific power					
1. A teacher could help you improve your math grades in one month.[a]	-.32**	-.40***	-.30*	-.17	.24*
2. How often does a teacher give you enough time to answer a question?	-.31**	-.33**	-.13	-.04	.25*
3. When the teacher gives you math problems to do, how often do you understand what you are supposed to do?	-.03	-.38**	-.29**	-.28**	.12
Nontask-specific power					
4. A teacher can answer almost all your questions.[a]	-.06	-.40***	-.19	-.24*	-.01
5. How much information does a teacher have?	-.21*	-.44***	-.21	-.29**	.21
6. I believe a teacher will always be right.[a]	-.15	-.52***	-.26*	-.23*	.21
Instability					
7. How often do you disagree with what a teacher says?				.13	-.01
8. Are you happy with having the teacher choose which math problems to give you?[a]				.58***	-.49***
9. Do you like doing math problems with the teacher?[a]				.61***	-.52***
Incompatibility					
10. Are you happy with the scores the teacher gives you on math problems?[a]					-.35***
Preference					
11. I would prefer to learn math from a teacher.[a]					

[a]Where appropriate, the response scale has been reversed.

* = $p < .05$

** = $p < .01$

*** = $p < .001$

authority system, the measures of power or resource capacity should be associated negatively with the measures of incompatibility and instability and positively with the measure of preference. The same pattern of relationships should be found among the measures applying to the computer authority system.

Examination of the data shown in Tables 18 and 19 indicate that the pattern of relationships described above does hold for both Non-CAI and CAI students; views regarding the teacher authority system. The measures of power were associated negatively with the measures of instability (with one exception) and incompatibility and positively with the measure of preference. Furthermore, the measure of incompatibility was associated positively with all three measures of instability and negatively with the measure of preference. In other words, the lower the level of power attributed by the students to their math teachers, the greater the likelihood that they would regard these teachers' evaluations as unsatisfactory (or incompatible with their own level of acceptable evaluations) and that their views about these teachers would denote instability, or a desire for change.

For the CAI group, the relationships among the measures of task-related power, incompatibility, instability and preference for computer (see Table 20) were also found to follow a pattern similar to that concerning the students' perception of the teacher (see Table 19). While the correlational matrix pertaining to the CAI students' perception of the computer (see Table 20) includes fewer significant coefficients, the associations among the four categories of measures were generally in the expected direction. That is, while there is a strong tendency for the propositions to hold among the teacher items for both Non-CAI and CAI students, this tendency was somewhat reduced with respect to computer

TABLE 20

Posttest Relationships Among Measures of Power, Instability, Incompatibility and Preference for Computer (CAI Group)

Items	Instability 7	8	9	Incompatibility 10	Preference 11
Task-specific power					
1. A computer could help improve your math grades in one month.[a]	-.58***	-.13	-.27*	-.22	.42**
2. How often does a computer give you enough time to answer a question?	+.01	-.17	-.30*	-.37**	.19
3. When the computer gives you math problems to do, how often do you understand what you are supposed to do?	.00	-.23	-.30*	-.01	.09
Nontask-specific power					
4. A computer can answer almost all your questions.[a]	-.12	-.26*	-.23	-.01	.07
5. How much information does a computer have?	-.18	-.07	-.15	.00	.13
6. I believe a computer will always be right.[a]	-.07	-.25*	-.00	-.09	.04
Instability					
7. How often do you disagree with what a computer says?				.00	-.37**
8. Are you happy with having the computer choose which math problems to give you?[a]				.23	-.10
9. Do you like doing math problems with the computer?[a]				.30**	-.42***
Incompatibility					
10. Are you happy with the scores the computer gives you on math problems?[a]					-.13
Preference					
11. I would prefer to learn math from a computer.					

[a]Where appropriate, the response scale has been reversed.
* = $p < .05$ ** = $p < .01$ *** = $p < .001$

items for CAI students, particularly for the relationships among the measures concerning incompatibility and preference.[11]

The availability of concurrent authority relations with the teacher and the computer afforded CAI students the possibility to compare and differentiate between several formal and informal aspects of these two systems. Hence, comparison between these students' views on the two systems may serve for a fuller examination of the theory.

The data from the CAI group provide the possibility to compare these students' views about both the teacher's and the computer's authority systems. It will be recalled from the previous section, that both the teacher and the computer were perceived by CAI students as having task-specific power (resource capacity) and task-specific authority (legitimate exercise of power). As can be seen in Table 21 on all items, except the one concerning the degree of understanding of allocations, CAI students saw the teacher and computer as having similar degrees of power.[12]

In view of these findings and the propositions above, for CAI students, the posttest data should indicate a greater tendency (than was found in the pilot study) toward similar levels of incompatibility, instability, and preference for the teacher and computer. Support for this is found in Table 22.

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[11]This latter finding may reflect a significant increase from pilot study to posttest in incompatibility with regard to the computer and a corresponding decrease in preference for doing computer problems.

[12]In the pilot study, on all items, except the one concerning time, CAI students saw the computer as having significantly greater power than the teacher. However, from the pilot study to the posttest, there were significant increases in the teacher power items concerning "questions," "time," and "understanding." These findings again seem to reflect a more resourceful teacher, resulting from the personnel changes discussed earlier. Also, there was a significant decrease from the pilot study to the posttest in CAI students' belief that the computer is "always right," which seems to reflect a more realistic view of the CAI program.

TABLE 21

Posttest Comparisons Between Teacher and Computer on Power (Resource Capacity) Items (CAI Group)

	Items	Teacher $\bar{X}$	Computer $\bar{X}$	t[a]	
	Task-specific power				
1.	A teacher (computer) could help you improve your math grades in one month.	2.19	2.15	.20	N.S.
2.	How often does a teacher (computer) give you enough time to answer a question?	2.57	2.29	1.40	N.S.
3.	When a teacher (computer) gives you math problems to do, how often do you understand what you are supposed to do?	2.29	2.62	-2.36*	
	Nontask-specific power				
4.	A teacher (computer) can answer almost all your questions.	2.30	2.34	- .24	N.S.
5.	How much information does a teacher (computer) have?	2.77	3.02	-1.47	N.S.
6.	I believe a teacher (computer) will always be right.	2.98	2.70	1.65	N.S.

[a]Two-tailed t.
* = $p < .05$

CAI students appeared to experience a similar degree of incompatibility with the computer's and the teacher's evaluations of their performance; that is, from these students' point of view, evaluations which are unsatisfactory to them are no more likely to come from the computer than from the teacher.[13]

[13]In the pilot study, the teacher's evaluations were significantly more likely than the computer's to be unsatisfactory; however, there was a significant decrease from the pilot study to the posttest in incompatibility with the teacher's evaluations.

TABLE 22

Posttest Comparisons Between Teacher and Computer on Measures of Incompatibility, Instability and Preference (CAI Group)

Items	Teacher $\bar{X}$	Computer $\bar{X}$	t[a]	
Incompatibility				
Are you happy with the scores the teacher (computer) gives you on math problems?	2.35	2.05	1.76	N.S.
Instability				
Are you happy with having the teacher (computer) choose which math problems to give you?	2.15	2.05	.71	N.S.
Do you like doing math problems with the teacher (computer)?	2.15	2.82	-3.05**	
How often do you disagree with what a teacher (computer) says?	2.16	1.53	4.50***	
Preference				
I would prefer to learn math from a teacher (computer).	1.75	2.00	1.25	N.S.

[a]Two-tailed t
** = $p < .01$
*** = $p < .001$

For CAI students there were significant differences between teacher and computer authority systems on two of the three measures of instability; that is, these students appeared to experience significantly less liking for performing tasks with the teacher than the computer, and more frequent disagreement with the teacher's than the computer's messages.[14]

[14]In the pilot study CAI students also experienced significantly less satsifaction with the teacher's than the computer's task allocations, but the degree of satisfaction with teacher allocations increased significantly from the pilot study to the posttest.

It is not surprising then to find that, as far as tasks related to learning mathematics are concerned, CAI students indicated no significantly greater preference for having them monitored by either the computer or the teacher.[15]

In addition, the propositions concerning authority figures were tested for teacher and computer indices with Non-CAI students' views of the teacher as an authority figure compared to CAI students' views of the computer as an authority figure. Evidence supporting the set of propositions concerning both teacher and computer authority systems is found in Tables 23 and 24.

TABLE 23

Posttest Intercorrelations Among Teacher Authority Indices
(Non-CAI Group)

	1	2	3	4
1. Power	1.00			
2. Incompatibility	- .42***	1.00		
3. Instability	- .56***	.62***	1.00	
4. Preference	.21	- .19	- .24*	1.00

* = $p < .05$
*** = $p < .001$

[15]In the pilot study, CAI students indicated a significantly greater preference for having math tasks monitored by the computer than by the teacher; however, from the pilot study to the posttest there was an increasing preference for teacher-monitored tasks and a corresponding decrease in preference for computer-monitored tasks.

TABLE 24

Posttest Intercorrelations Among Computer Authority Indices
(CAI Group)

	1	2	3	4
1. Power	1.00			
2. Incompatibility	- .11	1.00		
3. Instability	- .34*	.41**	1.00	
4. Preference	.18	- .06	- .39**	1.00

* = $p < .05$
** = $p < .01$

For Non-CAI students' views of teacher authority, all of the relationships were in the direction predicted, and four of the six coefficients were significant. That is, except for two relationships involving preference, the propositions among indices concerning teacher authority appeared to hold. Interestingly, except for the nonsignificant coefficient between power and incompatibility, Table 24 concerning intercorrelations among computer authority indices for CAI students indicated the same pattern of relationships found among teacher indices. That is, there was a striking similarity in the patterns of relationships among authority indices for teacher and computer; thus, CAI students' views of computer authority were much the same as Non-CAI students' views of the regular authority figure, the teacher.

This finding was interpreted as supporting the idea that for CAI students, the computer functions as an authority figure, thus providing authority relations for goal attainment concurrent to those of their regular authority figure, the teacher. Based on Emerson (1962), having concurrent authority relations for goal attainment with the computer is

argued to potentially reduce students' dependency on the teacher's task-specific resources. Thus, the remainder of the study investigates some of the effects of CAI experience on student perception of teacher authority, particularly its impact on their views of the teacher's task-specific power.

IV. SOME EFFECTS OF CAI ON STUDENT PERCEPTION OF TEACHER AUTHORITY

Before investigating some effects of CAI on student perception of teacher authority, some reformulations of theory and method are required.

A. Theoretical Additions and Modifications.

For purely substantive reasons of providing a more comprehensive view of interrelationships among dimensions related to teacher authority, the inquiry will become more complex in the number of indices. One of the two additional indices concerns how often students see the teacher as helping them to achieve better academic grades and to attain academic goals. The two items forming this index and their intercorrelations are found in Table 25. The second index involves students' general evaluation of the teacher as an authority figure. It consists of three evaluation dimension items from the semantic differential concerning teacher. The content of the items (i.e., the adjective pairs of opposites) and their intercorrelations are shown in Table 26.

TABLE 25

Posttest Correlation Between Goal Attainment Items
(Total Group)

Items	1	2
1. The math teacher helps you learn to do math problems.	1.00	
2. The math teacher helps you get better math grades.	.43***	1.00

*** = $p < .001$

TABLE 26

Posttest Correlations Among Teacher Evaluation Items
(CAI and Non-CAI Groups)

Items		1	2	3
1. Fair-Unfair	CAI	1.00		
	Non-CAI	1.00		
2. Bad-Good	CAI	-.74***	1.00	
	Non-CAI	-.71***	1.00	
3. Like-Dislike	CAI	.80***	-.76***	1.00
	Non-CAI	.68***	-.69***	1.00

*** = $p < .001$

Theoretical Propositions.

To investigate the applicability of the additional theoretical notions to the functions of the teacher in the authority structure of the school, data were used to examine the following propositions:

1. Goal attainment is unlikely to be experienced in an authority system in which the authority's power (resource capacity) is low.
2. Goal attainment is unlikely to be experienced in an incompatible authority system.
3. Goal attainment is unlikely to be experienced in an unstable authority system.
4. An authority system in which the authority's power is low, is unlikely to be highly evaluated.
5. An incompatible authority system is unlikely to be highly evaluated.
6. An unstable authority system is unlikely to be highly evaluated.
7. An authority system in which goal attainment is unlikely to be experienced is not likely to be preferred.

Effects of Personnel Changes on Student Perception of Teacher Authority: Examination of the Propositions.

There were a number of changes (71% turnover) in math personnel at the end of the 1968-69 school year, just after the pilot study was completed. It is argued that personnel change of such magnitude may have an important impact on the way in which students view teacher authority. Evidence of this is found in Tables 27 and 28, in which student views of 1968-69 teachers are compared with those of 1969-70 teachers.

TABLE 27

Comparisons Between Pilot Study and Pretest Teacher Power Items (Means for 1968-69 and 1969-70 Students)

Items	Pilot Study Teacher (June 1969) $\bar{X}$	Pretest Teacher (December 1969) $\bar{X}$	t[a]
Task-specific power			
1. A teacher could help you improve your math grades in one month.	2.37	2.17	1.94
2. How often does a teacher give you enough time to answer a question?	2.17	2.44	-2.93**
3. When a teacher gives you math problems to do, how often do you understand what you are supposed to do?	2.26	2.45	-2.44*
Nontask-specific power			
4. A teacher can answer almost all your questions.	2.52	2.33	2.19*
5. How much information does a teacher have?	2.72	2.85	-1.35
6. I believe a teacher will always be right.	3.08	2.92	1.77

[a]Two-tailed t
* = $p < .05$
** = $p < .01$

From the 1968-69 to the 1969-70 school year, students reported increased resourcefulness on the part of teachers in every case, and for three of the six items, they described the new teachers as singificantly more resourceful than their former teachers, especially in regard to task-specific areas.

TABLE 28

Comparisons Between Pilot Study and Pretest Teacher on Measures of Incompatibility, Instability, Preference, and Evaluation Items (Means for 1968-69 and 1969-70 Students)

Items	Pilot Study Teacher (June 1969) $\bar{X}$	Pretest Teacher (December 1970) $\bar{X}$	t[a]
Incompatibility			
Are you happy with the scores the teacher gives you on math problems?	2.11	2.37	-2.57*
Instability			
Are you happy with having the teacher choose which math problems to give you?	1.74	2.11	-3.72***
Do you like doing math problems with the teacher?	1.91	2.29	-3.56***
How often do you disagree with what a teacher says?	2.33	2.13	2.45*
Preference			
I would prefer to learn math from a teacher.	2.01	1.60	3.57***
Evaluation			
Fair-Unfair	3.03	2.17	5.48***
Bad-Good	3.04	3.78	-4.90***
Like-Dislike	3.18	2.61	3.48***

[a]Two-tailed t
* = $p < .05$
*** = $p < .001$

Students also appeared to experience a significantly lower degree of incompatibility with their new teacher's than their former teacher's evaluations of their performance; that is, from the students' point of view, evaluations which are unsatisfactory to them, are much less likely to come from the new teacher than from the former teacher. There were also significant differences between 1968-69 and 1969-70 teacher authority systems on all three measures of instability. That is, students appeared to experience greater satisfaction with the new teacher's than the former teacher's task allocations, greater liking for performing tasks with the new teacher than with the former one, and less frequent disagreement with the new teacher's than the former teacher's messages.

In view of the propositions regarding teacher authority systems, these findings concerning teacher authority were expected to have an impact on the variables added to the system; that is, the authority system of the pretest teacher should provide greater opportunity for goal achievement, be more positively evaluated, and be more preferred than that of the pilot study teacher. Support for these notions are found in Tables 28 and 29.

Students experienced significantly greater goal attainment with their new teacher than with their previous teacher; that is, students felt that their new teacher, more often than their old teacher, helped them to learn to do math problems and to get better math grades (see Table 29). It is not surprising then to find that the new teacher received significantly more positive evaluations than did the former teacher on all three of the semantic differential items (see Table 28). Also, as far as tasks related to learning mathematics are concerned, students indicated a significantly greater preference for having them monitored by the new teacher than by the former teacher (see Table 28).

TABLE 29

Comparisons Between Pilot Study and Pretest Teacher Goal Attainment Items (Total Group)

Items	Pilot Study Teacher (June 1969) $\bar{x}$	Pretest Teacher (December 1969) $\bar{x}$	t[a]
1. The math teacher helps you learn to do math problems.	2.40	2.73	-4.80***
2. The math teacher helps you get better math grades.	2.08	2.37	-3.40***

[a]Two-tailed t
*** = $p < .001$

Thus, from the pilot study to the pretest of the present investigation, there is a significant trend on the part of students toward a more positive view of teacher authority. This trend, coupled with fading general normative support for students having authority relations with the computer (see Chapter 3, p. 35), provides the setting for investigating some effects of CAI on student perception of teacher authority--particularly the idea that experience of CAI provides concurrent authority relations for goal attainment with the computer, thereby reducing students' dependency on teacher's task-specific resources (i.e., bringing about a reduction in student perception of teacher's task-specific power).

B. Methodological Modifications.

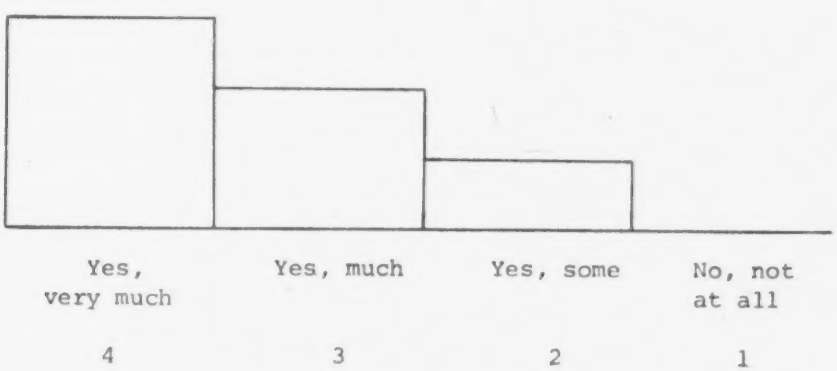
At this stage of the inquiry into the effects of CAI, there is a need to become more rigorous in the techniques of analysis, since the investigation has become more complex in the number of variables. This involves making certain assumptions about the data (e.g., interval scale properties), which sometimes introduces certain costs in predictability, but the statistical power gained more than makes up for this loss.

Formation of Indices.

Since scales which vary between zero and one have certain desirable statistical qualities, all variables in the model were made to vary in this way by using simple arithmetic operations: each item's scale was reduced by 1.0 (and reversed when appropriate), making the origin the lowest point on the scale; each item was then divided by the number of nonzero points on its scale, making 1.0 the highest point on the scale.

For example, one item used as a measure of instability with respect to the teacher was stated in the following way:

Are you happy with having the teacher choose which math problems to give you?



First, students' scores on this item were reduced by one, making them range from 3.0 to 0, instead of from 4.0 to 1.0. Since this particular item deals with satisfaction, the scale was reversed in order to reflect the notion of instability, making the scores range from 0 to 3.0, rather than from 3.0 to 0. The scores obtained were then divided by the number of nonzero points on the scale (three in this case), thus making the scores range from 0 to 1.0. This method was especially convenient for forming indices, since it assigned equal weight to items originally having different sized scales. Finally, each index was formed by dividing the sum of the item scores by the number of items, thus making each index score vary from 0 to 1.0.

Table 30 shows the intercorrelations among the derived teacher indices. It is recognized, however, that the organizational phenomena of interest comprise a highly complex system of interrelated variables and, as such, cannot be examined properly within the limitations of the statistical procedure of simple correlational analyses.

TABLE 30

Posttest Intercorrelations Among Teacher Indices
(Total Group)

Index	1	2	3	4	5	6
1. Power	1.00					
2. Incompatibility	-.40***	1.00				
3. Instability	-.57***	.63***	1.00			
4. Preference	.23**	-.28***	-.36***	1.00		
5. Goal Attainment	.37***	-.39***	-.42***	.34***	1.00	
6. Evaluation	.39***	-.45***	-.48***	.27***	.26***	1.00

** = $p < .01$
*** = $p < .001$

Mathematical Models.

Multiple regression, a powerful statistical tool, is now being employed to explore complex systems by building models of the interrelated variables using systems of simultaneous equations. When such a system fulfills certain properties of identification (i.e., adheres to certain rules concerning the numbers of equations and unknowns), it is solvable and provides best, unbiased estimates of the regression coefficients by using ordinary least squares.

The Preliminary Model as a Recursive System.

Econometricians have become accustomed to highly complex causal systems involving large numbers of interrelated variables under non-experimental conditions. The common solution has been to use entire sets of simultaneous equations, known as structural systems. Blalock (1964) has described and used a simplified subclass of these structural systems referred to as recursive. A recursive system is one in which two-way causality is ruled out. For example, the model consisting of the set of hypotheses previously outlined in Chapter 3 constitutes a recursive system. Employing the usual notations of mathematics, the hypotheses concerning that set of four variables may be rewritten in the following way:

Let Power = X_1

Incompatibility = X_2

Instability = X_3

Preference = X_4

Then $X_1 = e_1$

$X_2 = b_{21} X_1 + e_2$

$X_3 = b_{31.2} X_1 + b_{32.1} X_2 + e_3$

$X_4 = b_{41.23} X_1 + b_{42.13} X_2 + b_{43.12} X_3 + e_4$

Where e_i = error term, consisting of variables operating outside the system (i.e., exogenous variables)

And b_j = regression coefficient (i.e., some simple or partial correlation)

Here, the constant terms are dropped by assuming that each variable is measured in terms of deviations from its mean.

Now, X_1 (power) is assumed to be independent of all the rest and is determined only by variables that are "exogenous" or outside the causal system. "Endogenous" variables are those within the causal system (i.e., in this case, X_1, X_2, X_3, and X_4). But X_2 (incompatibility) is dependent not only upon exogenous variables but upon X_1 as well. Likewise, X_3 (instability) depends upon X_1, X_2, and exogenous variables but not upon the remaining endogenous variable X_4. Finally, X_4 depends upon all three endogenous and exogenous variables.

Problems in Evaluating the Recursive Model.

The regression coefficients take on the triangular form characteristic of the recursive system, with half of the b's having been set equal to zero. Unfortunately, however, this particular model (Figure 1) cannot be "tested" or evaluated in terms of correctional data until certain restrictions are imposed on the model. That is, in order to provide a simple test of the model there must be fewer unknowns than equations to provide excess information or conditions to be satisfied in order for the equations to be mutually consistent with the data. This may be accomplished by setting one or more of the remaining b's equal to zero (i.e., some total or partial correlation is assumed to be zero).

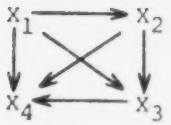


Figure 1
(Model 1)

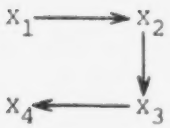


Figure 2
(Model II)

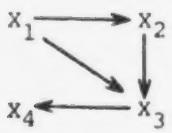


Figure 3
(Model III)

By reducing the number of causal arrows in the "untestable" model shown in Figure 1, (e.g., by assuming the simple causal chain in Model II), a set of prediction equations may be generated for evaluation using the correlational data found in Table 30.

Let Power = X_1

Incompatibility = X_2

Instability = X_3

Preference = X_4

It is expected that not only should

$$r_{24.3} = 0, \text{ or } r_{24} = r_{23} \cdot r_{34}$$

and

$$r_{13.4} = 0, \text{ or } r_{13} = r_{12} \cdot r_{23}$$

but also

$$r_{14} = r_{12} \cdot r_{23} \cdot r_{34}$$

Figure 3 indicates an alternative causal model (Model III) that the author considers theoretically more appropriate, since power is expected to have a direct effect on instability in addition to its indirect effect through incompatibility. Now it is expected that

$$r_{24} = r_{23} \cdot r_{34} \quad (\text{since } r_{24.13} = r_{24.3} = 0)$$

and

$$r_{14} = r_{13} \cdot r_{34}$$

TABLE 31

Predictions and Degrees of Fit of Model II and Model III for Posttest Teacher Authority Variables (Total Student Group)

Predictions	Degrees of Fit
Model II	
	Actual vs. Expected
$r_{24} = r_{23} \cdot r_{34}$	$-.28$ vs. $-.23 = (.63)(-.36)$
$r_{13} = r_{12} \cdot r_{23}$	$-.57$ vs. $-.25 = (-.40)(.63)$
$r_{14} = r_{12} \cdot r_{23} \cdot r_{34}$	$.23$ vs. $.09 = (-.40)(.63)(-.36)$
Model III	
	Actual vs. Expected
$r_{24} = r_{23} \cdot r_{34}$	$-.28$ vs. $-.23 = (.63)(-.36)$
$r_{14} = r_{13} \cdot r_{34}$	$.23$ vs. $.21 = (-.57)(-.36)$

Table 31 shows that while the expected values of r_{24} for both models are exactly the same, that expected for r_{14} in Model III (.21) comes much closer to the actual (.23) than does Model II (.09). Also, Model III assumes the actual value of r_{13} (-.57), whereas Model II does not (i.e., Model II merely provides an expected value of (-.25). Thus, Model III provides the better set of prediction equations for this set of correlational data.[16] This, however, does not necessarily establish the correctness or validity of Model III but merely eliminates Model II, since other causal models using these four variables could also be tested.

[16]This was expected since Model III also provided a better fit than Model II of both the pilot study and the pretest data.

Evaluating the Six-variable Recursive Model.

Derived from the results of stepwise regression analyses of the pilot study and the pretest data, the additional propositions stated above regarding goal attainment and evaluation were combined with the results of evaluating the four-variable model; stepwise regression analysis was used with the posttest data to examine the resultant set of expected relationships among the six indices concerning the teacher authority system. Thus, power was expected to be negatively related to incompatibility and instability and positively related to goal attainment and evaluation. Incompatibility was expected to be positively related to instability and negatively related to goal attainment and evaluation. Instability was expected to be negatively related to goal attainment, evaluation, and preference. Goal attainment was expected to be positively related to preference. Evidence supporting these expectations is found in Table 32.

TABLE 32

Stepwise Multiple Regressions of a Recursive System of Linear Equations Concerning Six Teacher Authority Indices (Total Posttest Group)

R	R^2	Standard Error	Preference	Evaluation	Goal Attainment	Instability	Incompatibility	Power	Constant
.41	.17	.27	I*		.27 (.10)**	-.40 (.13)			.80
.53	.28	.25		II		-.36 (.15)	-.25 (.10)	.38 (.21)	.70
.47	.23	.23			III	-.25 (.13)	-.17 (.09)	.37 (.19)	.78
.72	.52	.14				IV	.34 (.04)	-.61 (.10)	.65
.40	.16	.25					V	-.91 (.17)	1.00

*I-V represent the regression number and dependent variable.
**Numbers in parentheses represent the standard error of the estimate.

All of the expected relationships (represented by the regression coefficients) were found to be significant and in the predicted direction. That is, the slope of the power coefficient was negative in the regression equations regarding incompatibility and instability but positive in those concerning goal attainment and evaluation; the slope of the incompatibility coefficient was found to be positive in the regression equation concerning instability and negative in those regarding goal attainment and evaluation; the slope of the instability coefficient was negative in the equations regarding goal attainment, evaluation, and preference; and the slope of the goal attainment coefficient was found to be positive in the equation concerning preference.

Elaboration of the Recursive Model.

Teacher power. Up to this point, the analysis has concerned the relationships among six important organizational indices regarding teacher power, incompatibility, instability, goal attainment, evaluation, and preference. Thus far, power has operationally consisted of a single general index; however, at this point in the analysis it becomes necessary to incorporate the distinction made earlier between task-specific and nontask-specific power (see Chapter 3, p. 37 and Table 25 above). While it is expected that the two types of power will be positively correlated and that both are likely to be modified by experience of CAI, the degree and direction of the impact of CAI may differ. That is, under conditions of providing concurrent (or an alternative set of) authority relations for goal attainment, experience of CAI is argued to be more likely to impinge upon students' views of teacher's task-specific power (i.e., to reduce students' dependency on teacher's task-specific resources) than upon their views of teacher's nontask-specific power.

Exogenous variables. For substantive reasons of providing a more comprehensive view of the range of CAI effects, the inquiry will become more complex in the number of indices concerning the teacher authority system. That is, the six-variable recurisve model will be extended by including several exogenous variables (or variables considered to be outside the endogenous system). Further expansion of the model will also enable the system to account for greater proportions of the variance in the endogenous or dependent variables. While this is not at this time a critical factor from a sociological perspective, it is of vital importance to educators making policy decisions concerning the development of CAI and its uses in schools.

One obvious exogenous variable was simply the constant term for each equation, since it must be treated, if included, as an exogenous variable in the system. Another exogenous or outside variable expected to have effects on the endogenous system was an index of how frequently the teacher monitors the students' task performance (i.e., "When you have done a math problem, does the teacher tell you if your are right or wrong?" and "How often does the teacher check your math problems?"). The frequency with which the teacher monitored task performance was expected to be positively related to the degree of the teacher's task-specific power and to the degree to which students experienced goal achievement with the teacher. A third exogenous variable involves the degree of inconsistency between perceived teacher criteria and student-preferred criteria for evaluating their task performance (for the exact wording of the five criteria, four task-specific and one nontask-specific, see Table 8, Chapter 3). For each student, the absolute difference between his teacher's and his own preference for each of the five criteria was divided by 3.0, the largest possible absolute difference; the sum of

these terms was divided by 5 (the number of items) to allow the student's index of criteria inconsistency to vary from 0 to 1.0. The degree of criteria inconsistency was expected to be negatively related to student evaluation of the teacher; that is, the greater the inconsistency perceived by students between the teacher's and their own criteria of evaluation, the lower their evaluation of the teacher as an authority figure. A fourth variable involves an index of the students' general evaluation of the textbook as a source of authority. This item consists of three evaluation dimension items from the semantic differential (the same ones used for the Teacher Evaluation index, i.e., fair-unfair, bad-good, and like-dislike) as applied to the teacher. Theoretically, the perceived quality of the textbook should have important outside effects on the endogenous system, particularly on the teacher's general power, the degree of incompatibility experienced, and the students' evaluation of the teacher. That is, quality of textbook should be positively related to the teacher's nontask-specific power or resource capacity, negatively related to the degree of incompatibility experienced in authority relations with the teacher, and positively related to student evaluation of the teacher. Initial support for these expectations is found in Table 33, which shows the intercorrelations among these exogenous indices (with the exception of the constant term) and the endogenous indices.

TABLE 33

Posttest Intercorrelations Among Exogenous and Endogenous Indices Concerning the Teacher Authority System (Total Group)

	Indices:	Task-specific power	Nontask-specific power	Textbook Evaluation	Monitoring Frequency	Criteria Inconsistency
	Endogenous					
1.	Preference	.24**	.15*	.20**	.21**	-.07
2.	Evaluation	.35***	.29***	.44***	.15*	-.20**
3.	Goal Attainment	.36***	.25**	.12	.39***	-.14*
4.	Instability	-.55***	-.39***	-.36***	-.28***	.11
5.	Incompatibility	-.35***	-.31***	-.33***	-.25**	.06
6.	Task-specific power	1.00	.35***	.23**	.27***	-.09
7.	Nontask-specific power		1.00	.31***	.11	-.12
	Exogenous					
8.	Textbook Evaluation			1.00	.12	-.08
9.	Monitoring Frequency				1.00	-.07
10.	Criteria Inconsistency					1.00

* = $p < .05$
** = $p < .01$
*** = $p < .001$

Exogenous indices of CAI experience. An exogenous variable of great importance to this study is that of the treatment or CAI experience. In addition to having the actual number of block- and strand-type CAI lessons (described in Chapter 2) experience of CAI was operationalized as two variables representing the three groups--Non-CAI, first-year CAI, and second- and third-CAI students--i.e., as dummy variables rather than as a single continuous one. This was done by the following process.

If the student was Non-CAI, then CAI1 = 0 and CAI2 = 0.

If the student was first-year CAI, then CAI1 = 1 and CAI2 = 0.

If the student was second- or third-year CAI, then CAI1 = 0 and CAI2 = 1.

Table 34 shows the intercorrelations among indices of CAI and the other indices.

TABLE 34

Posttest Intercorrelations Among CAI Indices and Other Indices Concerning the Teacher Authority System (Total Group)

	Indices	CAI1	CAI2	Blocks	Blocks and Strands	Strands
	Endogenous					
1.	Preference	-.17*	.08	-.02	-.04	-.05
2.	Evaluation	-.17*	.01	-.03	-.10	-.16*
3.	Goal Attainment	-.08	.05	.07	.02	-.04
4.	Instability	.13	-.05	-.03	.02	.07
5.	Incompatibility	.16*	-.17*	-.07	-.05	-.03
6.	Task-specific power	-.10	-.12	-.07	-.17*	-.24**
7.	Nontask-specific power	.16*	-.03	.24**	.17*	.08
	Exogenous					
8.	Textbook Evaluation	-.25*	.03	-.07	-.12	-.14*
9.	Monitoring Frequency	-.11	.16*	.04	-.00	-.04
10.	Criteria Inconsistency	.07	.12	.18*	.20**	.19*
11.	CAI1	1.00	-.22**	.58***	.61***	.55***
12.	CAI2		1.00	.37***	.37***	.31***
	Blocks			1.00	.93***	.72***
	Blocks and Strands				1.00	.93***
	Strands					1.00

* = $p < .05$
** = $p < .01$
*** = $p < .001$

C. Effects of CAI Experience on Items and Indices Concerning Teacher Authority and Textbook Evaluation.

Goal Attainment.

The results in Table 35 showed no significant differences among the three groups on the items and index regarding posttest goal attainment, holding constant pretest differences. That is, CAI appeared to have little or no direct effect on the frequency with which students perceived the teacher as helping them attain academic goals.

TABLE 35

Analysis of Covariance: Comparisons Between CAI and Non-CAI Posttest Means, Adjusted for Pretest Scores on Goal Attainment Items and Index

Items:	Non-CAI $\bar{X}$	1st-yr. CAI $\bar{X}$	2nd & 3rd yr. CAI $\bar{X}$	F
1. The math teacher helps you learn to do math problems.	2.67	2.61		.39 N.S.
2. The math teacher helps you get better math grades.	2.34	2.22		1.03 N.S.
Index	.753	.706		1.09 N.S.
	.755	.708	.763	.64 N.S.

Textbook Evaluation.

The data in Table 36 showed that, for two of the three textbook evaluation items, the adjusted posttest means of first-year CAI students were significantly lower than those of Non-CAI students. That is, first-year CAI students were more likely to dislike and think of the textbook as bad than were Non-CAI students, holding constant pretest differences on these items.

TABLE 36

Analysis of Covariance: Comparisons Between CAI and Non-CAI Posttest Means, Adjusted for Pretest Scores on Textbook Evaluation Items and Index

Items: (adjective pairs)	Non-CAI $\bar{X}$	1st-yr. CAI $\bar{X}$	2nd & 3rd yr. CAI $\bar{X}$	F
1. Fair-Unfair	2.36	2.60		1.45 N.S.
2. Bad-Good	3.75	3.04		9.90**
3. Like-Dislike	2.61	3.15		4.52*
Index	.648	.527		7.67**
	.645	.524	.652	4.32*

* = $p < .05$
** = $p < .01$

These findings were reflected in the adjusted mean comparisons among student groups regarding the Textbook Evaluation index. The adjusted posttest means of first-year CAI students were significantly lower than those of Non-CAI and of more experienced second- and third-year CAI students. That is, first-year CAI students were more likely to negatively evaluate the textbook than were their Non-CAI and second- and third-year CAI peers. Further support of this finding was indicated by the significant negative partial correlation (-.24, $p<.001$) between the posttest Textbook Evaluation index and CAI1 (the dummy variable indicating first-year CAI students as opposed to Non-CAI and CAI2 students), holding constant pretest Textbook Evaluation.

Teacher Evaluation.

For two of the three teacher evaluation items (see Table 37), the adjusted posttest means of first-year CAI students were significantly lower than those of Non-CAI students. This indicates that the first-year CAI students were more likely to dislike and think of the teacher as bad than were Non-CAI students, holding constant their pretest differences on these items. These findings were reflected but were not significant in the comparisons among student groups regarding the Teacher Evaluation index. This latter finding was further substantiated by the fact that while holding constant pretest teacher evaluation, there was a singificant negative partial correlation (-.17, $p<.05$) between the Teacher Evaluation index and CAI1 (first-year CAI students as opposed to all others); however, the effect of CAI1 washed out by also holding constant grade level and pretest text evaluation. This suggests that first-year experience of CAI has an indirect effect of reducing teacher evaluations by producing significantly lower textbook evaluations.

TABLE 37

Analysis of Covariance: Comparison Between CAI and Non-CAI Posttest Means, Adjusted for Pretest Scores on Teacher Evaluation Items and Index

Items: (adjective pairs)	Non-CAI $\bar{X}$	1st-yr. CAI $\bar{X}$	2nd & 3rd yr. CAI $\bar{X}$	F
1. Fair-Unfair	2.66	2.73		.078 N.S.
2. Bad-Good	3.64	3.05		6.98**
3. Like-Dislike	2.76	3.35		6.39*
Index	.599	.502		3.48 N.S.
	.590	.494	.650	2.47 N.S.

* = $p < .05$
** = $p < .01$

Incompatibility

The results of analyses of covariance in Table 38 showed that while the differences between first-year CAI students and Non-CAI students on the posttest Incompatibility index were not significant, they were significant among all three groups. The differences were particularly great between first-year and the more experienced second- and third-year CAI students; that is, while first-year CAI students experienced a high degree of incompatibility with teacher's evaluations of their performance, second- and third-year CAI students experienced little of this. These findings were supported also by the partial correlation analysis. That is, holding constant pretest differences of incompatibility produced two significant partial correlations, a positive partial correlation (.19, p .05) between the Incompatibility index and CAI1 (first-year CAI students as compared to all others) and a negative partial correlation (-.25, p .001) between the Incompatibility index and CAI2 (second- and third-year CAI students).

TABLE 38

Analysis of Covariance: Comparisons Between CAI and Non-CAI Posttest Means, Adjusted for Pretest Scores on Incompatibility and Preference Indices

Indices:	Non-CAI $\bar{X}$	1st yr. CAI $\bar{X}$	2nd & 3rd yr. CAI $\bar{X}$	F
Incompatibility Index	.530	.615		3.29 N.S.
	.536	.621	.350	6.48***
Preference Index	.523	.644		3.57 N.S.
	.529	.653	.564	1.98 N.S.

*** = $p < .001$

Preference.

The results in Table 38 indicated no significant differences in teacher preference among the three groups; however, a significant positive partial correlation (.17, $p<.05$) was found between the Preference index and CAI2, holding constant pretest preferences. This suggests that second- and third-year CAI students, compared to all others (both first-year CAI and Non-CAI students), indicated greater preference for having authority relations for goal attainment with the teacher.

Monitoring Frequency.

While there were no significant differences on the task monitoring items and index between first-year CAI students and Non-CAI students (see Table 39), the more experienced second- and third-year CAI students perceived the teacher as monitoring their tasks significantly more often than did other students. This finding is supported also by the significant positive partial correlation (.20, $p<.05$) between the Task Monitoring index and CAI2; that is, second- and third-year CAI students as a group reported the teacher as monitoring their task performance more often than did their peers.

TABLE 39

Analysis of Covariance: Comparisons Between CAI and Non-CAI Posttest Means, Adjusted for Pretest Scores on Monitoring Frequency Items and Index

Items:	Non-CAI $\bar{X}$	1st yr. CAI $\bar{X}$	2nd & 3rd yr. CAI $\bar{X}$	F
1. The math teacher checks your math problems.	2.79	2.79		.01 N.S.
2. When you have done a math problem does the teacher tell you if you are right or wrong?	2.63	2.52		.75 N.S.
Index	.710	.703		.28 N.S.
	.718	.700	.816	3.06 ($p < .05$)

Instability.

While the results in Table 40 indicated no differences among the three groups of students on the Instability items and index, a significant negative partial correlation (-.16, $<.05$) was found between the Instability index and CAI2. This suggests that second- and third-year CAI students, as a group compared to all other students, experienced significantly less instability in authority relations with the teacher.

TABLE 40

Analysis of Covariance: Comparisons Between CAI and Non-CAI Posttest Means, Adjusted for Pretest Scores on Instability Items and Index

Items:	Non-CAI $\bar{X}$	1st yr. CAI $\bar{X}$	2nd & 3 yr. CAI $\bar{X}$	F
1. How often do you disagree with what a teacher says?	2.20	2.15		.14 N.S.
2. Are you happy with having the teacher choose which math problems to give you?	2.25	2.07		1.84 N.S.
3. Do you like doing math problems with the teacher?	2.39	2.14		2.59 N.S.
Index	.508	.547		1.43 N.S.
	.513	.553	.446	2.13 N.S.

Criteria Inconsistency.

Data in Table 41 indicated no significant differences among the three student groups regarding the degree of inconsistency between the teacher's and their own criteria of evaluation. Important differences were found, however, by using more precise measures of CAI based upon the actual number of block- and strand-type lessons performed by each student.

TABLE 41

Analysis of Covariance: Comparisons Between CAI and Non-CAI Posttest Means, Adjusted for Pretest Scores on Criteria Inconsistency Items and Index

Items:	Non-CAI $\bar{X}$	1st yr. CAI $\bar{X}$	2nd & 3rd yr. CAI $\bar{X}$	F
What does the teacher care about on the math problems you do?				
Task-specific criteria				
1. How fast I do math problems.	.199	.180		.24 N.S.
2. If I get them right.	.135	.147		.10 N.S.
3. If I get them done.	.209	.288		2.68 N.S.
4. Having a neat paper.	.224	.290		1.74 N.S.
Nontask-specific criteria				
5. Other things, such as coming in late, being absent, talking too much.	.266	.281		.079 N.S.
Index	.209	.235		1.058 N.S.
	.209	.235	.271	1.483 N.S.

Holding constant pretest criteria inconsistency, significant positive correlations were found between the Criteria Inconsistency index and all three indices of CAI lessons, i.e., the Block index (.17, $p<.05$), the Strand index (.18, $p<.05$), and the Block and Strand (or combined) index (.19, $p<.05$). This means that the students who were more involved in the CAI program in terms of the number of lessons performed reported greater degrees of inconsistency between the teacher's and their own criteria of evaluation than did those with less or no involvement in CAI.

Power.

Evidence supporting the theoretical distinction made between task-specific and nontask-specific power is found in Table 42. First-year CAI students were found to have significantly different views than Non-CAI students concerning two of the six power items. Holding constant pretest differences, first-year CAI students were more likely than their Non-CAI peers to regard the teacher as a source of answers to questions but were less likely than the Non-CAI students to find the teacher presenting understandable allocations. That is, first-year CAI students were more likely than their Non-CAI peers to ascribe to the teacher a high degree of nontask-specific power but a low degree of task-specific power. While these opposing effects of CAI were obscured in the Total Power index, they were reflected in both the Task-specific and Nontask-specific Power indices but produced no significant differences.

These opposing effects of CAI were even more evident when analyzing the effects of CAI utilizing indices based upon the actual number of block- and strand-type lessons performed by each student. It will be recalled that the first half of the CAI treatment consisted of block-type lessons, while the second half utilized the more flexible and individualized strands approach. First, holding constant pretest perceptions of teacher's nontask-specific power, the partial correlation between the Nontask-specific Power index and the Block index was significant and positive (.22, $p<.01$). The effect of block lessons on task-specific power was negative but not significant. Secondly, there was a significant negative partial correlation between the Task-specific Power index and the Strand index (-.24, $p<.001$), holding constant pretest perceptions of teacher's task-specific power. The effect of strand lessons on nontask-specific power was positive but not significant.

TABLE 42

Analysis of Covariance: Comparisons Between CAI and Non-CAI Posttest Means, Adjusted for Pretest Scores on Power Items and Indices

	Items	Non-CAI $\bar{X}$	1st yr. CAI $\bar{X}$	2nd & 3rd yr. CAI $\bar{X}$	F
	Task-specific power				
1.	A teacher could help you improve your math grades in one month.	2.08	2.267		2.18 N.S.
2.	How often does a teacher give you enough time to answer a question?	2.62	2.71		.48 N.S.
3.	When a teacher gives you math problems to do, how often do you understand what you are suppose to do?	2.56	2.31		5.89*
	Nontask-specific power				
4.	A teacher can answer almost all your questions.	2.63	2.28		8.90**
5.	How much information does a teacher have?	2.89	2.79		.67 N.S.
6.	I believe a teacher will always be right.	3.10	2.95		1.86 N.S.
	Task-specific Power Index	.566	.529		1.9. N.S.
		.565	.527	.498	1.75 N.S.
	Nontask-specific Power Index	.463	.503		2.21 N.S.
		.461	.502	.473	1.24 N.S.
	Total Power Index	.551	.523		.20 N.S.
		.512	.515	.480	.15 N.S.

* = $p < .05$
** = $p < .01$

That is, the main effect of block-type CAI lessons appeared to be that of increasing student dependency on teacher's nontask-specific resources, while the main effect of strand-type lessons was a reduction in student dependency on teacher's task-specific resources. Finally, the partial correlation between the Block and Strand (or combined) index and the Task-specific Power index was significant and negative (-.17, $p<.05$), holding constant pretest task-specific power. The effect of the Block and Strand (or combined) index on nontask-specific power was positive but not significant. Thus, the main overall effect of the combined experience of block- and strand-type CAI lessons was that of reducing students' dependency on teacher's task-specific resources (i.e., bringing about a reduction in student perception of teacher's task-specific power).

This finding is consistent with Emerson's (1962) postulate that in a power-dependence relationship A's power over B is directly proportional to the extent that A can mediate between B and B's goals and inversely proportional to the extent that alternative (concurrent) power-dependence relations are available to B for goal attainment. Given the goal of learning mathematics and the specific tasks involved in this goal (i.e., solving math problems) it appears that, for CAI students, task-specific authority relations with the computer function concurrently to their relations with the teacher. This, in turn, reduces their dependency on teacher's task-specific resources, that is, brings about a reduction in student perception of teacher's task-specific power, a crucial basis for task-specific authority.

D. Effects of Exogenous Indices of CAI Experience on Endogenous Variables of the Recursive Model.

The findings above gained additional support in an analysis of the effects of CAI indices on endogenous variables concerning teacher authority contained in the recursive model outlined in Table 43. Stepwise multiple regressions of the seven linear equations were computed using posttest data from the total group to obtain estimates of the coefficients of the relevant variables. At this stage of the investigation, the coefficients pertaining to each of the indices of CAI experience were of special interest; thus, the regressions were run separately for each CAI index (the dummy variables CAI1 and CAI2 were considered together in each of the equations, since they were not highly correlated).

Effects of CAI1 and CAI2.

The effects of CAI1 and CAI2 are found in Table 43. The coefficient of the CAI2 variable was found to be negative in the equation concerning incompatibility. This reflects the earlier finding that second- and third-year CAI students, as a group, experienced less incompatibility than did their first-year CAI and Non-CAI peers.

The coefficients of both CAI1 and CAI2 were negative in the equation concerning task-specific power. Also, the coefficient of the CAI2 index (-.09) was nearly double that of the CAI1 index (-.05). These findings are congruent to those of the preceding section; that is, first, CAI students (of both types) were less likely than Non-CAI students to attribute to the teacher task-specific power, and secondly, this reduction effect of CAI experience on student perception of teacher's task-specific power was greater for second- and third-year CAI students than it was for first-year CAI students.

TABLE 43

Stepwise Multiple Regressions of the Recursive System of Linear Equations Indicating Effects of Exogenous Dummy Variables CAI1 and CAI2 on Endogenous Indices Concerning Teacher Authority (Total Group)

			Endogenous Variables							Exogenous Variables					
														Dummy Variables	
			Preference	Evaluation	Goal Attainment	Instability	Incompatibility	Task-specific Power	Nontask-specific Power	Constant	Textbook Evaluation	Monitoring Frequency	Criteria Inconsistency	CAI 1st year	CAI 2nd year
R	R^2	Standard Error	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6	Y_7	X_1	X_2	X_3	X_4	X_5	X_6
.41	.17	.27	I*		.27 (.10)**	-.40 (.13)				.80					
.59	.35	.24		II		-.36 (.13)	-.21 (.09)			.73	.33 (.09)		-.28 (.14)		
.54	.29	.22			III	-.21 (.13)	-.15 (.08)	.24 (.15)		.51		.40 (.11)			
.73	.53	.14				IV	.34 (.04)	-.46 (.08)	-.16 (.08)	.66					
.50	.25	.24					V	-.51 (.15)	-.28 (.14)	1.12	-.24 (.09)				-.18 (.06)
.47	.22	.13						VI	.33 (.07)	.26		.22 (.07)		-.05 (.02)	-.09 (.04)
.40	.16	.14							VII	.30	.24 (.05)			.09 (.03)	

*I-VI Represent the regression number and dependent variable.

**Numbers in parentheses represent the standard error of the estimate.

In the equation regarding nontask-specific power, the coefficient of the CAI1 variable was positive. This means that first-year CAI students attributed to the teacher greater degrees of nontask-specific power or resource capacity than did other students. This finding appears to reflect the opposing initial effects of CAI found earlier, i.e., first-year CAI students ascribed to the teacher lower degrees of task-specific power but higher degrees of nontask-specific power than did their Non-CAI peers.

Effects of Block- and Strand-type CAI lessons.

These opposing effects of CAI experience on indices of teacher power were also clearly evident in analyzing effects of CAI using indices based on the actual number of block- and strand-type CAI lessons performed by each student. Since the indices concerning block- and strand-type CAI lessons did not impinge upon variables in the first five equations, these were not repeated in Tables 44-46 (equation V is included in Table 44 to indicate the coefficients found without the presence of the exogenous dummy variables CAI1 and CAI2).

Block and strand effects. The coefficient of the index measuring the combined block- and strand-type CAI experience of students was found to be negative in the equation regarding task-specific power but positive in that concerning nontask-specific power (see Table 44). That is, in the recursive model the combined index of block- and strand-type CAI lessons had a negative effect (-.002) on teacher's task-specific power but an equal and opposite effect (+.002) on nontask-specific power. These findings indicate that the primary initial effect (i.e., that of the block-type lessons) of the overall treatment was that of increasing student dependency on teacher's nontask-specific resources, while the later impact (i.e., that of the more flexible and individu-

TABLE 44

Stepwise Multiple Regression of the Recursive System of Linear Equations Indicating Effect of Exogenous Block- and Strand-type CAI Experience on Endogenous Indices Concerning Teacher Authority (Total Group)

			Endogenous Variables				Exogenous Variables				
			Incompatibility	Task-specific Power	Nontask-specific Power	Constant	Textbook Evaluation	Monitoring Frequency	Criteria Inconsistency	Block & Strand CAI Lessons
R	R^2	Standard Error	Y_5	Y_6	Y_7	X_1	X_2	X_3	X_4	X_7
.48	.23	.25	V*	-.39 (.15)**	-.28 (.15)	1.22	-.25 (.09)	-.25 (.13)		
.48	.23	.13		VI	.35 (.07)	.26		.20 (.06)		-.002 (.001)
.40	.16	.14			VII	.36	.21 (.05)		-.15 (.08)	.002 (.001)

*V-VII represent the regression number and dependent variable.
**Numbers in parentheses represent the standard error of the estimate.

TABLE 45

Stepwise Multiple Regressions of the Recursive System of Linear Equations Indicating Effects of Exogenous Block-type CAI Experience on Endogenous Indices Concerning Teacher Authority (Total Group)

			Endogenous Variables		Exogenous Variables				
			Task-specific Power	Nontask-specific Power	Constant	Textbook Evaluation	Monitoring Frequency	Criteria Inconsistency	Block-type CAI Lessons
R	R^2	Standard Error	Y_6	Y_7	X_1	X_2	X_3	X_4	X_8
.45	.20	.13	VI*	.35 (.07)**	.26		.21 (.07)		-.002 (.001)
.43	.19	.14		VII	.36	.20 (.05)		-.16 (.08)	.004 (.001)

*VI-VII represent the regression number and dependent variable.
**Numbers in parentheses represent the standard error of the estimate.

alized strand-type lessons) was that of reducing student dependency on teacher's task-specific resources. Further evidence supporting these notions follows.

Block effects. The data in Table 45 indicate that the coefficient of the Block index was negative in the equation concerning task-specific power but positive in that regarding nontask-specific power. Also the absolute value of the coefficent in the latter equation (.004) was twice that found in the former (-.002). These findings suggest that block-type CAI lessons have the effect of bringing about a reduction in student perception of teacher's task-specific power but have a greater opposite effect on nontask-specific power. This reflects the earlier finding that the main effect of block-type CAI lessons appeared to be that of increasing student dependency on teacher's nontask-specific resources.

Strand effects. The effects of strand-type CAI lessons appeared to be just the opposite of those found with blocks (see Table 46). The coefficient of the Strand index was negative (-.004) in the equation concerning task-specific power, but its coefficient, though positive, was not significant in the equation regarding nontask-specific power. These findings suggest that the more individualized and flexible strand-type CAI lessons tended to bring about a reduction in student perception of teacher's task-specific power. This reflects the earlier finding that the main effect of strand-type CAI lessons was that of reducing student dependency on teacher's task-specific resources and is consistent with Emerson's (1962) postulate that A's power over B is inversely proportional to the extent that alternative (concurrent) power-dependence relations are available to B for goal attainment.

TABLE 46

Stepwise Multiple Regression of the Recursive System of Linear Equations Indicating Effects of Exogenous Strand-type CAI Experience on Endogenous Indices Concerning Teacher Authority (Total Group)

			Endogenous Variables			Exogenous Variables			
			Task-specific Power	Nontask-specific Power	Constant	Textbook Evaluation	Monitoring Frequency	Criteria Inconsistency	Strand-type CAI Lessons
R	R^2	Standard Error	Y_6	Y_7	X_1	X_2	X_3	X_4	X_9
.49	.24	.13	VI*	.33 (.07)**	.27		.20 (.06)		-.004 (.001)
.31	.10	.14		VII	.35	.20 (.05)			

*VI-VII represent the regression number and dependent variable.
**Numbers in parentheses represent the standard error of the estimate.

E. Measurement of Change: Evaluating the Causal Assumptions Underlying the Recursive Model.

Having data over time provided the opportunity to check the adequacy of the one-way causal assumptions built into the recursive model employed in the study. In a recent article, Bohrnstedt (1969: 113-122) suggests that unstandardized partial regression coefficients are better suited to the study of change than are cross-lagged coefficients or gain scores, since the latter two methods do not take into account inital position on a variable. Thus, to determine whether Y causes X or vise versa (or at least which variable is the dominant cause of the other), comparisons must be made of $b_{y_t x_0 \cdot y_0}$ with $b_{x_t y_0 \cdot x_0}$; that is, the coefficient between Y at $time_t$ and X at $time_0$, partialing out the effect of Y a $time_0$ must be

compared with the coefficient between X at $time_t$ and Y at $time_0$, partialing out the effect of X at $time_0$.

Coleman (1968: 448-452) argues, however, that Y's effect on X and X's effect on Y are not mutually exclusive and, therefore, must be examined as two separate questions, i.e., assume that Y and X can affect each other. This may be done by treating each variable as dependent in separate equations and solving them as a system. That is,

$$Y_t = a_1 + b_{11}Y_0 + b_{12}X_0 \text{ and}$$

$$X_t = a_2 + b_{12}X_0 + b_{22}Y_0$$

To this point, the implicit assumption has been that of a two-variable universe with data from individuals at time t and 0, i.e., the simplest two-variable case. Since this study concerns the problems of interdependence among many variables, there is a necessity to consider the more general system of n linear regression equations outlined below:

$$X_{1t} = a_1 + b_{11}X_{10} + b_{12}X_{20} + \ldots + b_{1n}X_{n0}$$

$$X_{2t} = a_2 + b_{21}X_{10} + b_{22}X_{20} + \ldots + b_{2n}X_{n0}$$

$$\vdots$$

$$X_{nt} = a_n + b_{n1}X_{10} + b_{n2}X_{20} + \ldots + b_{nn}X_{n0}$$

Solving this system of n linear equations involves highly complex techniques (i.e., two-stage least squares). This investigation, however has been concerned with the effects of exogenous (or given) variables on the system of endogenous interrelationships. By adhering to certain rules concerning the number of each equation's included endogenous and excluded exogenous variables, the system of linear equations is identifiable (i.e., able to achieve a certain balance between the number of equations and unknowns), is solvable, and, thus, provides best, unbiased estimates of the regression coefficients using ordinary least squares techniques. Letting Z_j represent the set of k exogenous variables, the

general system of n equations would take the following form:

$$X_{1t} = a_1 + b_{11}X_{10} + \ldots + b_{1n}X_{n0} + (c_{11}Z_1 + \ldots + c_{1k}Z_k)$$

$$\vdots$$

$$X_{nt} = a_n + b_{n1}X_{10} + \ldots + b_{nn}X_{n0} + (c_{n1}Z_1 + \ldots + c_{nk}Z_k)$$

Thus, any endogenous variable at $time_t$ (X_{nt}) is a function of (or dependent on) some combination of exogenous variables and endogenous variables at $time_0$ (plus some unknown or unmeasured factors for which the system does not take account).

Constructing the Change Model.

Following this procedure, a system of ten equations was constructed using ten endogenous variables (i.e., the nine teacher indices and the textbook evaluation index) and several exogenous variables. In addition to the constant term and the widely-used, strand-type CAI experience, exogenous variables included background indicators (i.e., sex, grade level, math level, ethnicity and IQ), the two dummy variables CAI1 and CAI2 (indicating length of time in the CAI program), and a pretest computer evaluation index (comprised of the same semantic differential items used with indices of teacher and textbook evaluation). The full change model is shown in Tables 47 and 48 below. The results in Table 47 consist of stepwise multiple regressions of equations I-VII, and those in Table 48 indicate the stepwise regressions of equations VIII-X.

Comparing the Recursive Model with the Change Model.

The regression equations comprising the recursive or oneway causal model (see Tables 43 and 46, pp. 82 and 86) were compared with those found in Table 47, which summarizes equations I-VII of the change model. In the equations regarding preference (I), goal attainment (III), and nontask-specific power (VII), none of the recursive model's causal assumptions were supported by the results found in the change model.

For the equation concerning instability (IV), only one of the recursive model's assumptions was supported by the change model results. Thus, as expected, instability was found to be affected by incompatibility; however, as equation V of the change model shows, the reverse was also true, i.e., incompatibility was affected by instability. In equation II regarding teacher evaluation, two of the four assumptions of the recursive model were supported by the results indicated in the change model, i.e., teacher evaluation was found to be a function of incompatibility and textbook evaluation.

The recursive model's assumptions in equations V and VI appeared to be supported by the results found with the change model. Three of the four assumptions concerning incompatibility (equation V) were supported; that is, as expected, incompatibility was found to be a function of task- and nontask-specific power and CAI2 experience. For the equation regarding task-specific power (VI), all three of the recursive model's assumptions were substantiated by results found in the change model; as expected, task-specific power was affected by nontask-specific power, monitoring frequency, and strand-type CAI experience.

In addition to the above, Table 48 shows the regression equations VIII-X of the change model. Posttest textbook evaluation (equation VIII) was found to be dependent upon pretest textbook, teacher, and computer evaluation, task- and nontask-specific power, and criteria inconsistency, upon grade and math level, and upon CAI1 experience. Posttest task monitoring frequency was dependent upon pretest task-specific power, teacher and computer evaluations, and monitoring frequency and upon IQ and CAI2 experience. Posttest criteria inconsistency was affected by that experienced at pretest and by the number of strand-type CAI lessons performed.

TABLE 47

Part 1 of the Stepwise Multiple Regressions of a System of Linear Equations Comprising a Change Model Concerning Some Effects of CAI on Student Perception of Teacher Authority (Total Group)

R	R^2	Standard Error	Regression Number & Dependent Variable	Endogenous Variables: Preference (Y_1)	Teacher Evaluation (Y_2)	Goal Attainment (Y_3)	Instability (Y_4)	Incompatibility (Y_5)	Task-specific Power (Y_6)	Nontask-specific Power (Y_7)	Textbook Evaluation (Y_8)	Monitoring Frequency (Y_9)	Criteria Inconsistency (Y_{10})	Exogenous Variables: Constant Term (X_1)	Sex (X_2)	Grade Level (X_3)	Math Level (X_4)	Ethnicity (X_5)	IQ (X_6)	Computer Evaluation (X_7)	Strand-type CAI Lesson (X_8)	Dummy Variables: CAI1 (X_9)	CAI2 (X_{10})
.39	.15	.28	I*	.27 (.09)**				-.24 (.10)						.47					.03 (.01)	.20 (.11)			.18 (.08)
.47	.22	.26	II		.32 (.09)			-.17 (.10)			.22 (.10)			-.62		.11 (.03)							
.43	.18	.23	III		.15 (.07)	.37 (.09)							-.32 (.15)	.32						.16 (.09)			
.49	.24	.18	IV				.43 (.09)	.13 (.07)				-.20 (.09)		.35									-.10 (.05)
.61	.37	.23	V	.15 (.08)			.47 (.12)	.30 (.09)	-.21 (.13)	-.25 (.11)				.69		-.06 (.03)		.08 (.05)				.08 (.05)	-.15 (.07)
.55	.30	.13	VI				-.30 (.06)			.17 (.06)		.20 (.07)		.32	-.04 (.02)	.02 (.01)					-.002 (.001)		
.55	.31	.13	VII					-.11 (.05)		.35 (.07)				.36	-.04 (.02)		-.08 (.02)			.13 (.05)			

*I-VII Dependent variables are Preference, Teacher Evaluation, Goal Attainment, Instability, and Incompatibility.

**Numbers in parentheses represent the standard error of the estimate.

These findings suggest that the recursive model's assumptions of one-way causality can be seriously questioned, since the change model indicated mutual effects between many variables. Nevertheless, the recursive model's assumptions regarding the effects of CAI experience appeared to be well grounded, particularly those concerning the impact of strand-type CAI lessons on student perception of teacher's task-specific power and the long-term effects of CAI (CAI2) on the degree to which students experience incompatibility in authority relations with the teacher.

Reduced Form of the Change Model.

The change model in its reduced form (see Table 48) shows each endogenous or dependent posttest variable as a function of only the exogenous or independent variables, i.e., CAI experience and other educationally relevant variables.

Posttest preference (equation I) was found to be a function of pretest computer evaluation and CAI1 experience; that is, teacher preference was enhanced by positive pretest computer evaluations but reduced by actual first-year CAI experience. Posttest teacher evaluation (II) was also affected by pretest computer evaluation and by grade level and the number of strand-type CAI lessons performed. That is, teacher evaluation was enhanced by positive pretest computer evaluations but was reduced, little by little, by each strand-type CAI lesson performed. Posttest goal attainment (III) was also found to be dependent upon pretest computer evaluation. Both posttest incompatibility (V) and instability (IV) were found to be a function of ethnicity; that is, Mexican American students, as an ethnic group, were more likely than other students to experience incompatibility and instability in authority relations with the teacher. Posttest incompatibility was also dependent

TABLE 48
Part II of the Stepwise Multiple Regressions of a System of Linear Equations Comprising a Change Model Concerning Some Effects of CAI on Student Perception of Teacher Authority
(Total Group)

R	R^2	Standard Error	Regression Number & Dependent Variable	Endogenous Variables										Exogenous Variables											
				Preference	Teacher Evaluation	Goal Attainment	Instability	Incompatibility	Task-specific Power	Nontask-specific Power	Textbook Evaluation	Monitoring Frequency	Criteria Inconsistency	Constant Term	Sex	Grade Level	Math Level	Ethnicity	IQ	Computer Evaluation	Strand-type CAI Lesson	Dummy Variables: CAI1	Dummy Variables: CAI2
				Y_1	Y_2	Y_3	Y_4	Y_5	Y_6	Y_7	Y_8	Y_9	Y_{10}	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
.50	.25	.21	VIII*		.13 (.08)**				.14 (.12)	.22 (.11)	.15 (.09)		-.22 (.14)	-.14		.06 (.03)	-.12 (.05)			.14 (.09)		-.13 (.04)	
.48	.23	.15	IV		.09 (.05)				.22 (.08)			.22 (.08)		.20					.02 (.01)	.17 (.06)			.13 (.04)
.26	.07	.14	X										.20 (.09)	.17							.003 (.001)		

*VIII-X Dependent variables are Textbook Evaluation, Monitoring Frequency, and Criteria Inconsistency.
**Numbers in parentheses represent the standard error of the estimate.

upon math and grade level and upon CAI1 experience; i.e., first-year CAI students were more likely than their peers to experience incompatibility in authority relations with the teacher.

Posttest task-specific power (VI) of the teacher was found to be affected by the number of strand-type CAI lessons performed; that is, as predicted, each strand-type CAI lesson brought about a small but significant reduction in student perception of the teacher's task-specific power. The teacher's nontask-specific power (VII), on the other hand, was affected by students' math level and their pretest evaluations of the computer.

Posttest textbook evaluation (VIII) was also a function of pretest computer evaluation and of CAI experience; that is, textbook evaluation was enhanced by positive pretest computer evaluations but was reduced by actual first-year CAI experience. Posttest task monitoring frequency was also affected by pretest computer evaluation and by sex, IQ, and CAI2 experience; that is, males more than females, students with higher more than those with lower IQ's, and CAI2 students more than all others, perceived the teacher as more frequently evaluating their task performance. The latter finding, i.e., that second- and third-year CAI students as a group perceived the teacher as monitoring their task performance more frequently than did other students, is interesting in light of the fact that one of the preconditions for students engaging in block- and strand-type CAI lessons was the teacher's infrequent monitoring of students' task performance. In addition, the degree of inconsistency reported by students between the teacher's and their own criteria of evaluation at the time of the posttest was generally increased by the number of strand-type CAI lessons the students performed; that is, each

TABLE 49
Stepwise Multiple Regressions (Reduced Form) of a System of Linear Equations Comprising a Change Model Concerning Some Effects of CAI on Student Perception of Teacher Authority (Total Group)

R	R^2	Standard Error	Regression Number	Dependent Variable	Exogenous Variables: Constant Term	Sex	Grade Level	Math Level	Ethnicity	IQ	Computer Evaluation	Strand-type CAI Lesson	Dummy Variables: CAI1	CAI2
.24	.06	.29	I	Preference	.67						.23 (.11)		-.12 (.05)	
.29	.09	.28	II	Teacher Evaluation	-.05		.07 (.03)*				.19 (.11)	-.005 (.002)		
.16	.03	.25	III	Goal Attainment	.62						.19 (.10)			
.18	.03	.20	IV	Instability	.45				.09 (.04)					
.37	.14	.26	V	Incompatibility	1.13		-.10 (.03)	.10 (.05)	.14 (.06)				.08 (.05)	
.24	.06	.14	VI	Task-specific Power	.57							-.004 (.001)		
.35	.13	.14	VII	Nontask-specific Power	.43			-.09 (.03)			.16 (.06)			
.32	.10	.23	VIII	Textbook Evaluation	.51						.22 (.09)		-.13 (.04)	
.36	.13	.16	IX	Monitoring Frequency	.49	.05 (.03)				.03 (.01)	.17 (.06)			.09 (.04)
.19	.04	.14	X	Criteria Inconsistency	.21							.003 (.001)		

*Numbers in parentheses represent the standard error of the estimate.

strand-type CAI lesson performed had a small but significant effect of widening the perceived gap between the teacher's and their own criteria of evaluation.

Of course, without the additional effects of the pretest endogenous variables the amount of variance explained in each posttest variable is greatly reduced; however, the model in this form does provide educators with some idea of how much the exogenous or educationally relevant variables by themselves affect each posttest variable.

V. Conclusions and Implications.

The findings that emerge in this study of some effects of CAI are relevant to educational practices involving interaction between students and nonhuman teachers and to sociological theory and methodology in the study of organizational and technological change, as applied to the social structure of the school.

The results are consistent with Emerson's (1962) postulate that in a power-dependence relationship, A's power over B is directly proportional to the extent that A can mediate between B and B's goals and inversely proportional to the extent that alternative (concurrent) power-dependence relations are available to B for goal attainment. That is, under conditions where CAI gains normative support by school officials authorizing its use as a monitor of students' task-specific behavior and where teachers are not able to achieve control of that technological resource, students interacting with CAI are likely to form alternative (or concurrent) authority relationships for goal attainment with the computer, to a degree and on a level comparable to those usually formed with their regular authority figure, the teacher.

A major effect of such involvement in CAI is that of reducing student dependence on the teacher's task-specific resources; that is, it brings about a reduction in student perception of the teacher's task-specific power, a critical basis for task-specific authority. By undermining the basis of the teacher's task-specific authority, CAI has certain unanticipated and less desirable consequences regarding the degree of incompatibility experienced, particularly by first-year CAI students. That is, instead of reducing incompatibility in authority relations with the teacher as expected, CAI's intervening effect of reducing the teacher's task-specific power brings about a significant increase in incompatibility experienced by first-year students.

An additional effect of CAI experience is that of reducing first-year CAI students' evaluations of the textbook. While this alone is not critical, its negative impact on their evaluations of the teacher, which subsequently reduces goal attainment appears to be an undesirable result. Goal attainment is even more directly reduced by CAI's effect on criteria inconsistency. Both block- and strand-type CAI lessons tend to increase the degree of inconsistency reported by students between the teacher's and their own criteria of evaluation, which has the undesirable effect of reducing perceived goal attainment. Thus, while CAI might be expected to increase the frequency with which students perceive the teacher as helping them achieve academic goals, CAI's intervening effects of reducing textbook and teacher evaluation and increasing criteria inconsistency appear to negate such positive expectations.

On the other hand, some of the longer range effects of the CAI program for the second- and third-year CAI group appear to be more favorable. That is, second- and third-year CAI students experience significantly less incompatibility and instability than do all other students and tend more than their peers to indicate greater preference for having authority relations with the teacher.

The implications of this investigation of some unplanned effects of CAI on pupils' attitudes toward and interaction with various components within the authority structure of the school fall into several general areas: educational technology, teacher training, and research tools and approaches in education and the social sciences.

1. One of the more important implications of this research to education is its focus on the noncurricular impact of a highly technological system of delivery on the consumer and its promise as a useful approach to analyzing some of the more empirically elusive and educationally important processes.

2. A specific implication resulting from the study is that the computer is perceived in terms of task-specific functions and does not bring with it the affective and evaluative overtones that teachers may bring into their relationships with students. This may have particular importance in teaching children who usually see themselves as objects of discrimination of one kind or another. For some students, the value-free responses of the computer and its lack of carryover of past performances (failures) may offer a more effective learning situation.

3. This study has implications for the analysis of teacher behavior and teaching processes by permitting differentiation of task- and nontask-specific functions, particularly those concerning the frequency and types of formal and informal evaluation and evaluative criteria used. This differentiation of instructional and affective elements in teaching will enable educational researchers to examine their relative effects in the teaching process.

4. Another important implication of this study is in the area of research on ways of preparing teachers to deal more effectively with such a potent technological system as CAI and with the possible threats that it may pose to some members of the teaching profession. The results of this examination and analyses extending this work should provide teachers and policy makers with a more explicit view of what the computer can and cannot affect. Educational researchers can begin to design more effective and efficient CAI programs and to enhance the academic strengths of current programs by optimizing the level of teacher control over the technological resource. Teacher training programs may then be based on a more realistic appraisal of what are the teacher's most effective strategies with, rather than in competition with, the machine.

5. The study has implications for utilizing research models in education and the social sciences. The study encourages the use of research models that are both theoretically and empirically based. It also finds great utility in stepwise multiple regression techniques for building and, later, testing and summarizing complex theoretical systems of interrelationships. In addition, the study lends support to the idea that unless there is substantial evidence already supporting the one-way causal arguments assumed by a recurisve model, a system assuming mutual effects is more likely to be appropriate for the study of change.

6. The change model developed in this investigation has some important implications for education and sociology in terms of its great potential as both a practical and analytical tool. While it summarizes processes of change in a multivariate system, it also provides both an empirical basis for manipulating a highly complex situation and an understanding of some of the probable consequences of such manipulation. In its reduced form, the change model shows each endogenous or dependent posttest variable as a function of only the exogenous or independent variables, i.e., CAI experience and other educationally relevant variables. This, along with the full model, may be used by educators to provide a more rational approach to making policy decisions, particularly in regard to CAI, its current and potential uses, and its probable effects on student perception of various aspects of teacher authority. The change model also offers sociologists a dynamic view of a system of linear equations summarizing the simultaneous effects of both exogenous and endogenous variables on some important organizational indices, as applied to the social setting of the school.

In summary, it is clear that the computer is not merely a dispenser of information, nor is it simply a sophisticated skill-builder. This

begins to recognize the extent to which CAI involves the student in highly complex systems of interaction which have unanticipated affective and social overtones in addition to and impinging upon its intended instructional function. The ways in which this interaction might be varied in future programs have potential effects not only upon what information and skills a student acquires but also upon the underlying social processes through which he relates himself to the interdependent systems, both technological and human, of a complex society.

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APPENDIX 1

(NOTE: The numbering of the items in this appendix reflects the data coding system. No items have been omitted.)

YOUR IDEAS ABOUT PEOPLE AND COMPUTERS

In this booklet there are some questions about the sorts of things students do at school and at home. Students have many different ideas about these things. We want to know what you think; we want your ideas.

This is not a school test. No one at school or at home will see what you put down.

Be sure to answer every question. There will be different kinds of questions and answers. As we go along, we will explain to you how you can show us what your idea is about each question.

Before you turn the page, print your name and your grade in the school. Please use capital letters.

NAME:_____

GRADE:_____

Here are some questions about things that may happen to a student at school and at home. We want to know how often they happen to you.

For example:

How often do your parents tell you what to do?

Your answer may be:

Usually, Sometimes, Almost never, Don't know

3 2 1 9

We will ask the same question for parents, math teacher, and computer. We want your answer on each of the three sentences. Choose one answer for each, and circle the number under it. If you want to change your answer, make a wavy line through the circled number which you want to change and circle the new number.

		Usually	Sometimes	Almost never	Don't know
(121)	The math teacher shows interest in the math work you do	3	2	1	9
(122)	The computer shows interest in the math work you do	3	2	1	9
(123)	Your parents show interest in the math work you do	3	2	1	9

		Usually	Sometimes	Almost never	Don't know
(124)	The math teacher punishes you when you do something wrong	3	2	1	9
(125)	The computer punishes you when you do something wrong	3	2	1	9
(126)	Your parents punish you when you do something wrong	3	2	1	9

		Usually	Sometimes	Almost never	Don't know
(127)	The math teacher chooses which math problems to give you	3	2	1	9
(128)	The computer chooses which math problems to give you	3	2	1	9

		Usually	Sometimes	Almost never	Don't know
(129)	The math teacher shows you how well or how poorly you are doing in math problems	3	2	1	9
(130)	The computer shows you how well or how poorly you are doing in math problems	3	2	1	9

		Usually	Sometimes	Almost never	Don't know
(131)	The math teacher helps you learn to do math problems	3	2	1	9
(132)	The computer helps you learn to do math problems	3	2	1	9
(133)	Your parents help you learn to do math problems	3	2	1	9

		Usually	Sometimes	Almost never	Don't know
(134)	The math teacher gets impatient with you	3	2	1	9
(135)	The computer gets impatient with you	3	2	1	9

		Usually	Sometimes	Almost never	Don't know
(136)	The math teacher helps you get better math grades	3	2	1	9
(137)	The computer helps you get better math grades	3	2	1	9
(138)	Your parents help you get better math grades	3	2	1	9

		Usually	Sometimes	Almost never	Don't know
(139)	The math teacher checks your math problems	3	2	1	9
(140)	The computer checks your math problems	3	2	1	9
(141)	Your parents check your math problems	3	2	1	9

		Usually	Sometimes	Almost never	Don't know
(142)	The math teacher corrects your behavior	3	2	1	9
(143)	The computer corrects your behavior	3	2	1	9
(144)	Your parents correct your behavior	3	2	1	9

The purpose of the next five pages is to find out what some words mean to you. On each page there is a different word. The word at the top of the first page is FRIEND. On each line under FRIEND there are two words, one on each side of it. There are five blank spaces between the words. The

words are: "hard-soft," "fast-slow," and so on. As you see, these words are opposites - hard is the opposite of soft, fast is the opposite of slow. Now think about the word FRIEND. If you think a friend is "hard," then put an X in the space next to "hard." If, on the other hand, you feel that a friend is "soft," then put an X next to "soft." Suppose you would choose the word hard but not too hard. Then you will put your X in the second space from "hard." Or, if you think that you would choose the word soft but not too soft then put your X in the second space from "soft." If you cannot make up your mind, put your X in the middle space. Now, remember, there are no right or wrong answers. Don't spend more than a couple of seconds on each line. Put your X in one of the spaces between the dots. Let's practice on the rest of the words under FRIEND.

EXAMPLE:

FRIEND

hard	_____:_____:_____:_____:_____	soft
fast	_____:_____:_____:_____:_____	slow
gives right answers	_____:_____:_____:_____:_____	gives wrong answers
fair	_____:_____:_____:_____:_____	unfair
bad	_____:_____:_____:_____:_____	good
cold	_____:_____:_____:_____:_____	warm
like	_____:_____:_____:_____:_____	dislike
confusing	_____:_____:_____:_____:_____	clear
big	_____:_____:_____:_____:_____	small
difficult	_____:_____:_____:_____:_____	easy

TEACHER

(145) hard _____:_____:_____:_____:_____ soft

(146) fast _____:_____:_____:_____:_____ slow

(147) gives right answers _____:_____:_____:_____:_____ gives wrong answers

(148) fair _____:_____:_____:_____:_____ unfair

(149) bad _____:_____:_____:_____:_____ good

(150) cold _____:_____:_____:_____:_____ warm

(151) like _____:_____:_____:_____:_____ dislike

(152) confusing _____:_____:_____:_____:_____ clear

(153) big _____:_____:_____:_____:_____ small

(154) difficult _____:_____:_____:_____:_____ easy

COMPUTER

(155) hard _____:_____:_____:_____:____ soft

(156) fast _____:_____:_____:_____:____ slow

(157) gives right answers _____:_____:_____:_____:____ gives wrong answers

(158) fair _____:_____:_____:_____:____ unfair

(159) bad _____:_____:_____:_____:____ good

(160) cold _____:_____:_____:_____:____ warm

(161) like _____:_____:_____:_____:____ dislike

(162) confusing _____:_____:_____:_____:____ clear

(163) big _____:_____:_____:_____:____ small

(164) difficult _____:_____:_____:_____:____ easy

T.V. NEWS

(165) hard _____:_____:_____:____:____ soft

(166) fast _____:_____:_____:____:____ slow

(167) gives right answers _____:_____:_____:____:____ gives wrong answers

(168) fair _____:_____:_____:____:____ unfair

(169) bad _____:_____:_____:____:____ good

(170) cold _____:_____:_____:____:____ warm

(171) like _____:_____:_____:____:____ dislike

(172) confusing _____:_____:_____:____:____ clear

(173) big _____:_____:_____:____:____ small

(174) difficult _____:_____:_____:____:____ easy

TEXTBOOK

(221) hard____:____:____:____:____ soft

(222) fast____:____:____:____:____ slow

(223) gives right answers____:____:____:____:____ gives wrong answers

(224) fair____:____:____:____:____ unfair

(225) bad____:____:____:____:____ good

(226) cold____:____:____:____:____ warm

(227) like____:____:____:____:____ dislike

(228) confusing____:____:____:____:____ clear

(229) big____:____:____:____:____ small

(230) difficult____:____:____:____:____ easy

Now you will find sentences like this:

Playing games is usually fun.

Strongly disagree	Disagree	Agree	Strongly agree	Don't know
4	3	2	1	9

The responses to this sentence go from "strongly disagree" to "strongly agree." Choose the response that comes closest to your idea and circle the number below it. If you cannot decide, circle the number under "don't know." Answer the following questions in the same way.

(231) Most students think that computers are hard to work with.

Strongly disagree	Disagree	Agree	Strongly agree	Don't know
4	3	2	1	9

(232) The idea of using a computer scares me.

Strongly disagree	Disagree	Agree	Strongly agree	Don't know
4	3	2	1	9

(233) Most big machines are really run by computers.

Strongly disagree	Disagree	Agree	Strongly agree	Don't know
4	3	2	1	9

(234) Most of my friends don't trust teachers.

Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1	2	3	4	9

(235) Most of my friends don't trust computers.

Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1	2	3	4	9

(236) Most of my friends don't trust T.V. news.

Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1	2	3	4	9

(237) A teacher could help you improve your math grades in one month.

Strongly disagree	Disagree	Agree	Strongly agree	Don't know
4	3	2	1	9

(238) A computer could help you improve your math grades in one month.

Strongly disagree	Disagree	Agree	Strongly agree	Don't know
4	3	2	1	9

(239) A teacher can answer almost all your questions.

Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1	2	3	4	9

(240) A computer can answer almost all your questions.

Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1	2	3	4	9

(241) Computers are smarter than people.

Strongly disagree	Disagree	Agree	Strongly agree	Don't know
4	3	2	1	9

(242) Computers are smarter than textbooks.

Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1	2	3	4	9

(243) A computer sometimes acts like a person.

Strongly disagree	Disagree	Agree	Strongly agree	Don't know
4	3	2	1	9

(244) A teacher never gets tired of working with you.

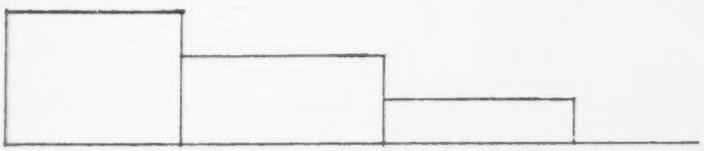
Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1	2	3	4	9

(245) A computer never gets tired of working with you.

Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1	2	3	4	9

Another kind of question you will find is like this:

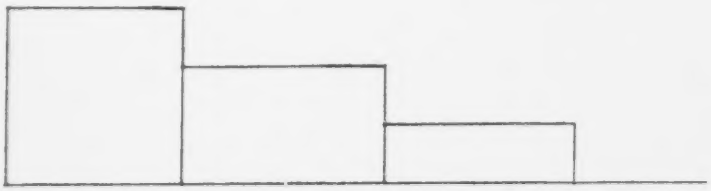
How often do you play games?



Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

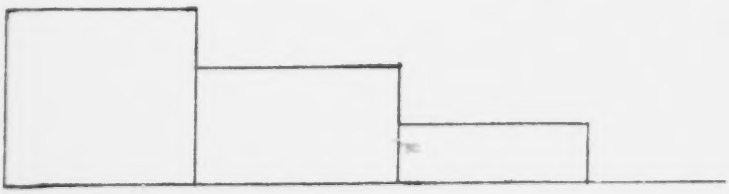
The responses here go from "always" to "never." Choose the response that comes closest to your idea and circle the number below it.

(246) How often do you know what a teacher is going to do next?



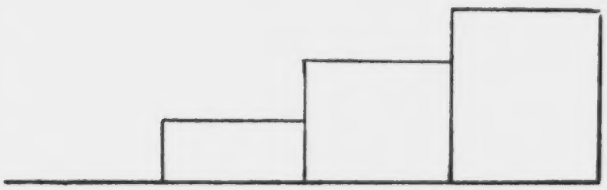
Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

(247) How often do you know what a computer is going to do next?



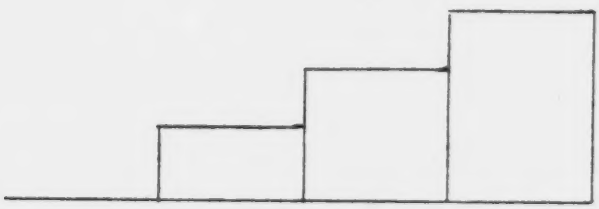
Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

(248) How often does a teacher give you enough time to answer a question?



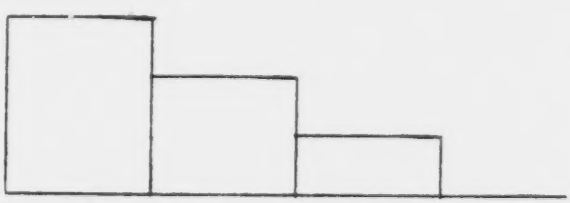
Never	Sometimes	Usually	Always	Don't know
1	2	3	4	9

(249) How often does a computer give you enough time to answer a question?



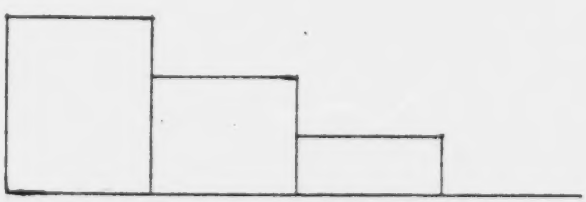
Never	Sometimes	Usually	Always	Don't know
1	2	3	4	9

(250) How often do you disagree with what a teacher says?



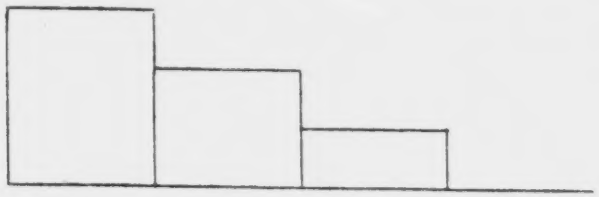
Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

(251) How often do you disagree with what a computer says?



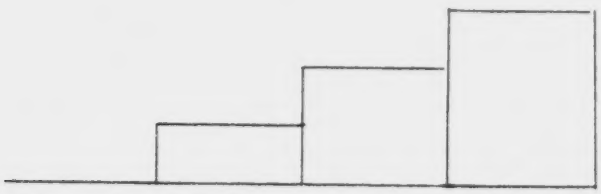
Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

(252) How often do you disagree with what a T.V. news says?



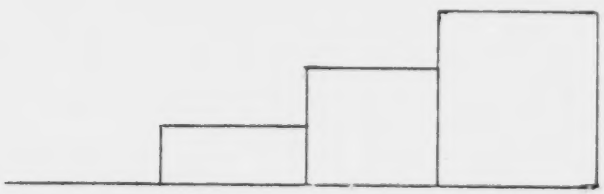
Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

(253) How much information does a teacher have?
(Circle the number under one answer only)



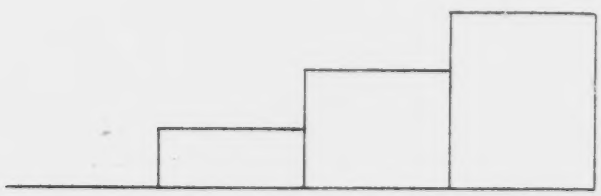
None	Some	Much	Very much	Don't know
1	2	3	4	9

(254) How much information does a computer have?



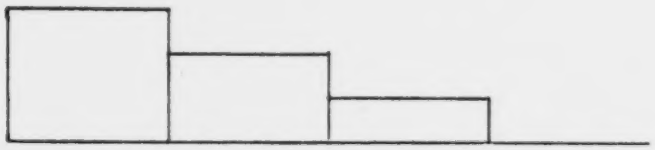
None	Some	Much	Very much	Don't know
1	2	3	4	9

(255) How much information does T.V. news have?



None	Some	Much	Very much	Don't know
1	2	3	4	9

(256) If you wanted to change something in a teacher's lesson do you think you could change it?



Yes, always	Yes usually	Yes sometimes	No, never	Don't know
4	3	2	1	9

(25) If you wanted to change something in a computer's lesson do you think you could change it?

Yes, always	Yes usually	Yes sometimes	No, never	Don't know
4	3	2	1	9

Which one decides what math lessons you get from the computer?

(Circle the number under "Yes," "No," or "Don't know" for each answer)

		Yes	No	Don't know
(258)	The math teacher decides	2	1	9
		Yes	No	Don't know
(259)	Somebody at Stanford decides	2	1	9
		Yes	No	Don't know
(260)	The score I got the day before decides	2	1	9
		Yes	No	Don't know
(261)	The computer supervisor decides	2	1	9
		Yes	No	Don't know
(262)	The computer decides	2	1	9

(263) I believe a teacher will always be right.

Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1	2	3	4	9

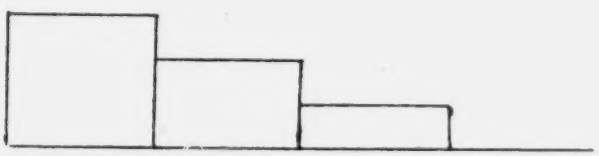
(264) I believe a computer will always be right.

Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1	2	3	4	9

(265) I believe a T.V. news will always be right.

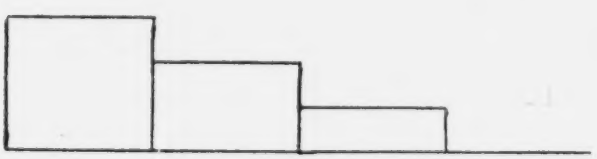
Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1	2	3	4	9

(266) When the teacher gives you math problems to do, how often do you understand what you are supposed to do?



Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

(267) When the computer gives you math problems to do, how often do you understand what you are supposed to do?



Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

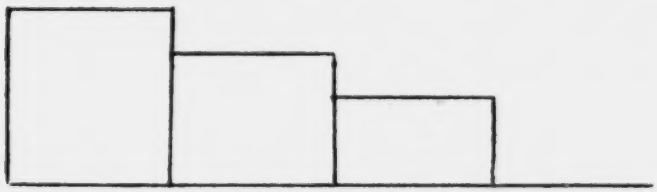
(268) How often does the teacher give you math problems which are too hard?

Never	Sometimes	Usually	Always	Don't know
1	2	3	4	9

(269) How often does the computer give you math problems which are too hard?

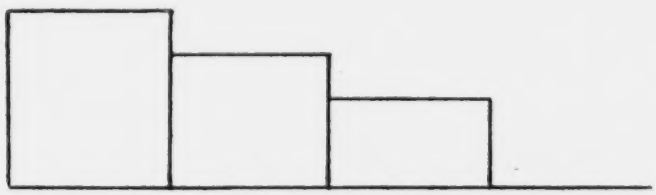
Never	Sometimes	Usually	Always	Don't know
1	2	3	4	9

(270) Are you happy with having the teacher choose which math problems to give you?



Yes, very much	Yes, much	Yes, some	No, not at all	Don't know
4	3	2	1	9

(271) Are you happy with having the computer choose which math problems to give you?



Yes, very much	Yes, much	Yes, some	No, not at all	Don't know
4	3	2	1	9

What can happen to students who do a poor job on math problems given by the teacher?
(Circle the number under "Yes," "No," or "Don't know" for each answer)

		Yes	No	Don't know
(272)	They get poor grades	2	1	9
(273)	The teacher frowns at them	2	1	9
(274)	The teacher won't like them	2	1	9
(275)	They have to stay after school	2	1	9

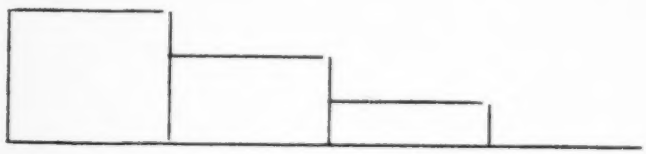
What can happen to students who do a poor job on math problems given by the computer?

		Yes	No	Don't know
(321)	They get poor grades	2	1	9
(322)	The teacher frowns at them	2	1	9
(323)	The teacher won't like them	2	1	9
(324)	They have to stay after school	2	1	9

How bad is this?
(Circle the number under one answer only for each line)

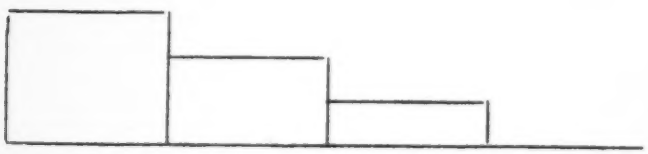
		Not bad at all	Not very bad	Bad	Very bad	Don't know
(325)	Getting poor grades	1	2	3	4	9
(326)	Getting frowns from the teacher	1	2	3	4	9
(327)	Not being liked by the teacher	1	2	3	4	9
(328)	Having to stay after school	1	2	3	4	9

(329) When you have done a math problem, does the teacher tell you if you are right or wrong?



Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

(330) When you have done a math problem, does the computer tell you if you are right or wrong?



Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

What do you care about on the math problems you do?

		Yes, much	Yes, some	Yes, a little	No, not at all	Don't know
(331)	How fast I do math problems	4	3	2	1	9
(332)	If I get them right	4	3	2	1	9
(333)	If I get them all done	4	3	2	1	9
(334)	Having a neat paper	4	3	2	1	9
(335)	Other things such as coming in late, being absent, talking too much	4	3	2	1	9

What does the math teacher care about on the math problems you do? (Circle the number under one answer only for each line)

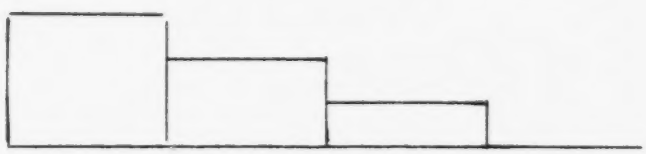
		Yes, much	Yes, some	Yes, a little	No, not at all	Don't know
(336)	How fast I do math problems	4	3	2	1	9
(337)	If I get them right	4	3	2	1	9
(338)	If I get them all done	4	3	2	1	9

		Yes, much	Yes, some	Yes, a little	No, not at all	Don't know
(339)	Having a neat paper	4	3	2	1	9
(340)	Other things, such as coming in late, being absent, talking too much.	4	3	2	1	9

What does the computer care about?
(Circle the number under one answer only for each line.)

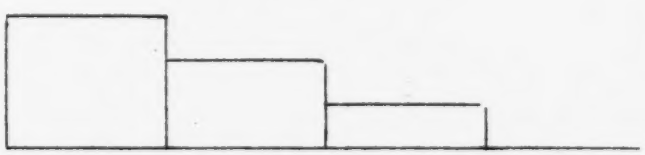
		Yes, much	Yes, some	Yes, a little	No, not at all	Don't know
(341)	How fast I do math problems	4	3	2	1	9
(342)	If I get them right	4	3	2	1	9
(343)	If I get them all done	4	3	2	1	9
(344)	Having a neat paper	4	3	2	1	9
(345)	Other things, such as coming in late, being absent, talking too much.	4	3	2	1	9

(346) Do you think that the scores you get on math problems from the teacher change your math grade?



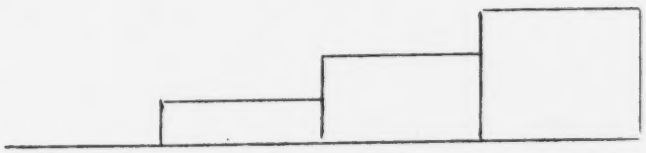
Yes, very much	Yes, much	Yes, a little	No, not at all	Don't know
4	3	2	1	9

(347) Do you think that the scores you get on math problems from the computer change your math grade?



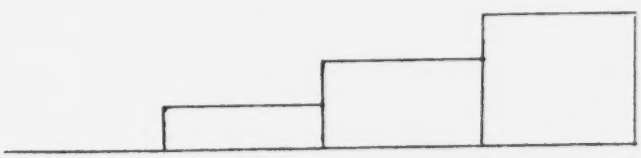
Yes, very much	Yes, much	Yes, a little	No, not at all	Don't know
4	3	2	1	9

(348) How much do you care about the scores the teacher gives you on math problems you do?



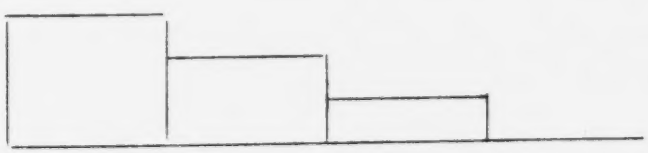
Not at all	A little	Much	Very much	Don't know
1	2	3	4	9

(349) How much do you care about the scores the computer gives you on math problems you do?



Not at all	A little	Much	Very much	Don't know
1	2	3	4	9

(350) Are you happy with the scores the teacher gives you on math problems?



Yes, very much	Yes, much	Yes, a little	No, not at all	Don't know
4	3	2	1	9

(351) Are you happy with the scores the computer gives you on math problems?

Yes, very much	Yes, much	Yes, a little	No, not at all	Don't know
4	3	2	1	9

(352) If you could choose, would the computer score more, the same or less of your math problems?

More	The same	Less	Don't know
3	2	1	9

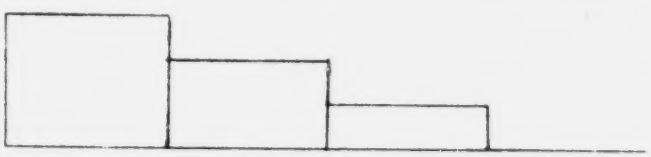
(353) If your math teacher could choose, would the computer score more, the same or less of your math problems?

More	The same	Less	Don't know
3	2	1	9

(354) If your friends could choose, would the computer score more, the same or less of their math problems?

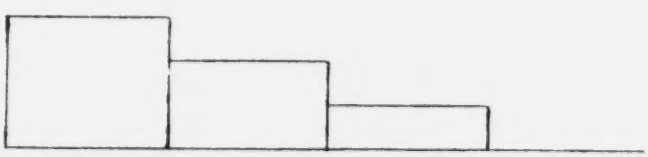
More	The same	Less	Don't know
3	2	1	9

(355) Do you like doing math problems with the math teacher?



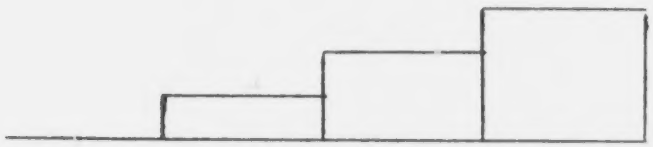
Yes, very much	Yes, much	Yes, a little	No, not at all	Don't know
4	3	2	1	9

(356) Do you like doing math problems with the computer? (Or do you think you would like it?)



Yes, very much	Yes, much	Yes, a little	No, not at all	Don't know
4	3	2	1	9

(357) How often does a computer break down?



Never	Sometimes	Usually	Always	Don't know
1	2	3	4	9

(358) How often does a T.V. set break down?

Never	Sometimes	Usually	Always	Don't know
1	2	3	4	9

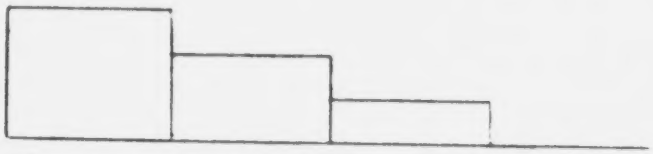
(359) How often does a teacher make a mistake?

Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

(360) How often does a computer make a mistake?

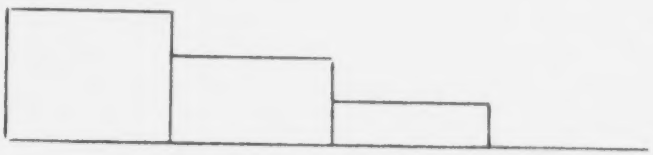
Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

(361) How often does the T.V. news make a mistake?



Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

(362) How often does a textbook make a mistake?



Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

I would prefer to learn math from a

(363) teacher____ (364) computer____ (365) T.V.____ (366) textbook____

Put a 1 next to your first choice, 2 for your second choice,
3 for your third choice, and 4 for your last choice.

APPENDIX 2
Excerpts of Computer Printout of a
CAI Drill-and-Practice Lesson

```
HI

PLEASE TYPE YOUR NUMBER AND NAME.
4 GEORGE WASHINGTON

HERE IS ANOTHER LESSON FOR YOU
     DRILL NUMBER L402013

 SUBTRACT

17 - 3  = 15
NO, TRY AGAIN

17 -  __ = 15
TIME IS UP, ANSWER IS 2, TRY AGAIN

17 - 2  = 15

___ - 10 = 10
TIME IS UP, TRY AGAIN

0  - 10 = 10
NO, ANSWER IS 20, TRY AGAIN

20  - 10 = 10

  36
- 28
   8

  38
- 19
 2 9
NO, TRY AGAIN

  38
- 19
 1 9

  15
-  7
   8

          END OF DRILL NUMBER L402013
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           JUNIOR UNIVERSITY.  ALL RIGHTS RESERVED.

26 FEB 70
10 PROBLEMS, 6 CORRECT IN 148 SECS. WITH 60PCT CORRECT


GOODBYE GEORGE, PLEASE TEAR OFF ON THE DOTTED LINE
```